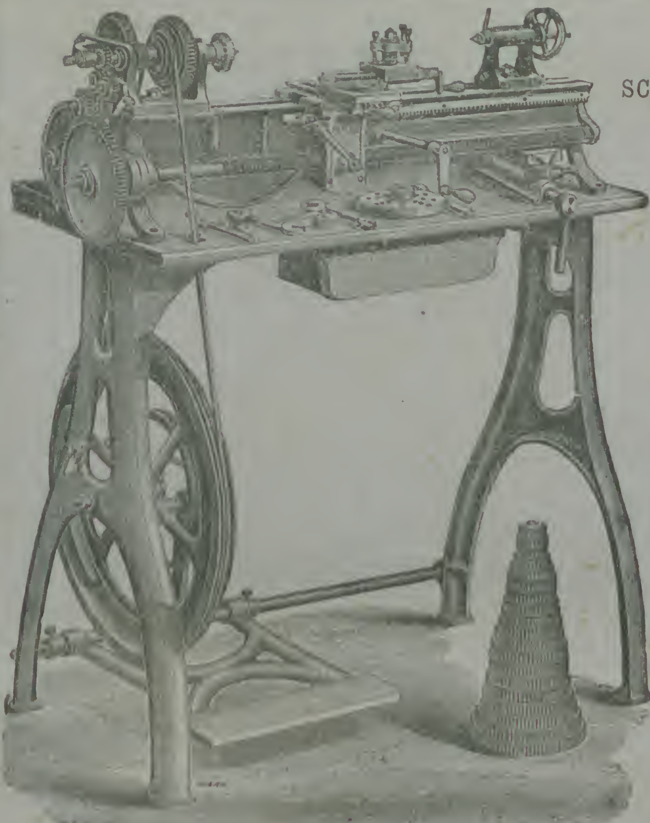
EVERY MAN HIS OWN MECHANIC

A COMPLETE GUIDE FOR AMATEURS



EVERY MAN HIS OWN MECHANIC.

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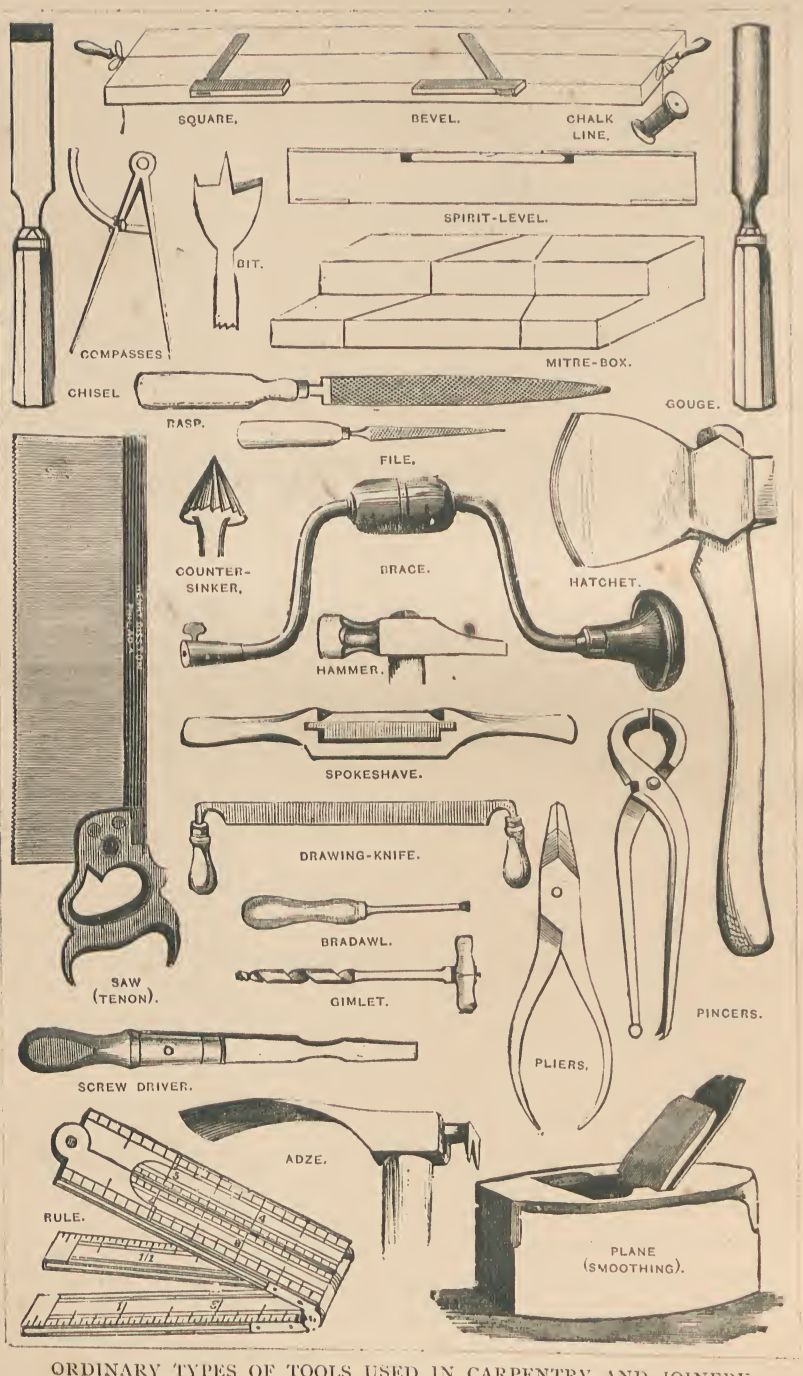

ORDINARY TYPES OF TOOLS USED IN CARPENTRY AND JOINERY.

(For Classification of Tools, see page 77.)

EVERY MAN
HIS OWN MECHANIC

A Complete and Comprehensive Guide

TO EVERY DESCRIPTION OF

CONSTRUCTIVE AND DECORATIVE WORK

THAT MAY BE DONE BY

THE AMATEUR ARTISAN,

AT HOME AND IN THE COLONIES.

IN THREE PARTS:—

PART I.
HOUSEHOLD CARPENTRY AND JOINERY.

PART II.
ORNAMENTAL AND CONSTRUCTIVE CARPENTRY.

PART III.
HOUSEHOLD BUILDING ART AND PRACTICE.

ILLUSTRATED WITH SEVEN HUNDRED AND FIFTY ENGRAVINGS ON WOOD.

LONDON:
WARD, LOCK, AND CO., WARWICK HOUSE,
SALISBURY SQUARE, E.C.

PREFACE.

For such a book as "Every Man His Own Mechanic" but few words in the form of an apology can be needed.

In its pages it has been sought to furnish the Amateur Artisan with hints and suggestions regarding all that he may undertake in Constructive and Decorative Work at home, and to show him clearly and in a thoroughly practical manner how each kind of manual labour is to be carried out, and with what appliances, tools, and materials it is to be done. If any think that simple operations are too fully and minutely described, it must be remembered that this book is not put forth as a text-book for skilled artisans, but rather as a guide for those who are altogether inexperienced in handicraft, or very nearly so, and therefore need to know something about the very A B C of the work that they propose to take in hand. The information presented in its pages is practical and reliable. It has been gathered chiefly from observation and actual experience, and the book is therefore offered to those who have a liking for Carpentry and Joinery, and the various departments of the Building Trade, in the hope that they may find in it a *vade-mecum*, which the writer has often desired to have when engaged in the various kinds of handiwork that are described therein. Much that is said in it cannot be found in any recognised text-book, because the authors of such works take for granted that those for whom they write know all about the elements of their craft, and that it is therefore needless to say anything about them. In this they are

right enough, but, on the other hand, it is in this very respect that their books fail to meet the requirements of amateurs.

It is just possible that some may think that too much has been said about tools and appliances of various kinds to be purchased, their prices, and the persons of whom, and the places where, they may be obtained. This, however, has been done purposely, for it is next to useless to speak of any article in a work that is intended to be of as much service as possible to its readers, without mentioning where it may be bought, both good and at a price which is sufficient to insure its goodness. If it be thought to have the appearance of *advertising*, the writer can say without the slightest reservation, that neither he nor the publishers have benefited directly or indirectly to the value of even so much as a penny-piece, by the mention of persons, places, and things that has been made; and more than this, the writer is personally known to only two of those persons whose names are mentioned. In every case attention has been called to their wares for the guidance and benefit of the readers only; and, surely, in these days when things are not always what they ought to be, or what their makers profess them to be, it cannot be amiss to say—*Caveat emptor*.

F. Y.

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EVERY MAN HIS OWN MECHANIC.

PART I.

Household Carpentry and Joinery.

TIMBER, TOOLS, AND SIMPLE PROCESSES.

Whatsoever thy hand findeth to do, do it with thy might.—*Ecclesiastes* ix. 10.

CHAPTER I.

INTRODUCTORY—KNOWLEDGE OF THE MECHANICAL ARTS USEFUL TO ALL MEN.

Requirements of the times—Competition more keen—Those most affected—Noticeable signs of the struggle—Adulteration and other trade frauds—Advance in prices: how caused—The artisan his own tax-master—Strikes raise prices—Incomes of clergy, etc., inelastic—Self-help possible and desirable—A case in point—Broken window: how to mend it—Cost of materials—What the workman will do—Professional charges—Labour must be paid for—Building operations: why expensive—Artisans' wages—Cost of job per time—Scale of wages—Decorator's wages—Prices charged by builders—Every man has time for necessary work—Knowledge and practice, how to obtain them—Knowledge must be paid for—Technical education—Workshops attached to schools—Practical knowledge, to whom useful—Choice of handicraft trade—Carpentry most desirable—Wireworking—Bricklaying and masonry—Setting stone or step—Excavating—Carpentry and joinery—Carpentry, why attractive to amateurs—Amateur's working dress—Working man: meaning and application of term—Artisan, artificer, and artist—Social distinctions nothing—The carpenter and his work—The joiner and his work—Derivation of these terms—Carpentry, how divisible.

Requirements of the times.

1. THE changes that have gradually come over all things during the years that have passed since the Great Exhibition of 1851 have rendered men far more inclined to regard and consider the signs of the times than they were wont to do during the first half of the present nineteenth century, and any one who will do this earnestly and searchingly cannot but come to the conclusion that the field of a man's knowledge must be far wider, his education far more general, his self-reliance far stronger, and his power to help himself far greater than was either thought to be necessary or found to be useful some fifty years ago or even less.

2. Although there are many causes which have helped indirectly to produce this result, the reason for it is mainly to be found in the fact that though the world does not grow larger its inhabitants are increasing more rapidly year by year, and that, in proportion to the increase in number, competition in the fight for life becomes more keen, and the struggle to make both ends meet more difficult and laborious.

Competition more keen.

3. The ranks of society on which the burden of competition has fallen most heavily, and which have been most seriously affected by the heat of the hand-to-hand battle for existence in which they have found themselves involved, are those which combine to form its great middle class, and include the bulk of the clergy, officers in the army and navy, professional men of all denominations, wholesale merchants, and retail tradesmen who buy and sell to get gain, and clerks of every description.

Those most affected.

4. The outward noticeable signs of the struggle are shown most clearly in the appearance of retail shops of most kinds in the present day. Some fifty years ago every trade confined itself to the sale of its own peculiar wares, and the heterogeneous contents of the general shop in the village, or that of the small tradesman in a country town, who sold drapery, perhaps, on one side of his useful premises, and groceries on the other, was often a matter of somewhat derisive comment. But now this is the rule and by no means the exception in "establishments" of far higher pretensions and greater extent. The grocer trenches on the province of the wine-merchant and the publican, and sells wines and spirits; and the licensed victuallers and innkeepers in just retaliation sell tea to any who will buy it of them. The draper will set out his window with articles that properly belong to the fancy goods warehouse and the toyshop. The oilman and provision-dealer sometimes dabbles in carpets, hearth-rugs, and ironmongery, and so the confusion in trades becomes more confounded from year to year, until at last intending buyers will find a difficulty in determining to what shop they had better go in order to get the wares they want.

Noticeable signs of the struggle.

5. These are some of the results of competition as shown in retail shops. Undue competition, too, has led to adulteration and other frauds in trade, so that the tolerably general practice that has prevailed of charging excessive prices for really good and genuine articles, and selling at moderate prices things which are not what they seem or pretend to be, has driven the upper strata of the middle classes to find relief in co-operation and co-opera-

Adulteration and other trade frauds.

tive societies, very much to the detriment of the fair-dealing tradesman, which is to be sincerely regretted, although the fault lies not in the co-operators, but to those who have driven them to such protective measures in defence of purse and pocket.

6. But there are other ways in which middle-class people, whose income is obtained by other ways than that of buying and selling, have suffered of late years, as, for example, the advanced prices of many things which have not been met by corresponding advances in their incomes. And how have these advances in prices been caused? Mainly by the action of the lower classes, who by repeated strikes to obtain increased wages, have contributed greatly to force up the prices of food, clothing, and house rent, and thereby impoverish the middle classes without gaining any solid benefit for themselves. House rent has been increased notably of late years by the strikes in all branches of the building trade, for when labour and materials rise in price the cost of building a house must both increase *pari passu;* and the builder or owner must of necessity demand and obtain a higher rent in order to get sufficient remuneration for the money he has sunk in bricks and mortar. And as house rent increases, so do rates and taxes increase, and the weight of the burden falls on the back of the middle classes, who are the chief contributors to the revenues of the country—national and local.

Advance in prices—how caused.

7. I say this advisedly. It has been pretty clearly shown of late years that the artisan is his own tax-master, and may regulate his contributions to the national income by swallowing more or less beer and spirits, and by smoking more or less tobacco, as inclination may lead him. In 1870 about £89,000,000 was expended in spirits alone in the United Kingdom, of which £58,000,000, or nearly two-thirds, came out of the pockets of the lower classes. Now as men are obliged neither to drink nor to smoke, the taxation paid in this respect is altogether voluntary; and the artisan may, if he choose, reduce his fiscal burdens to a minimum, as he pays no income tax, although frequently earning more than the clerk who does; while the duty still remaining on tea, etc., is inconsiderable. Nor are his payments in the shape of local rates and taxes by any means burdensome, for they are indirect; that is to say, included in the rent that he pays—weekly in most cases—to his landlord, and therefore not felt in any oppressive degree. The middle-class man, on the contrary, if he be a householder, is compelled *nolens volens* to pay poor rates, watch, or police rates, and other local taxes, and house duty and income tax to the national taxes; and as all taxation of this

The artisan his own tax-master.

nature is direct, and paid in lump sums, the burden is all the more hard to meet and all the more oppressive. Surely, as far as contribution to national and local rates and taxes is concerned, the artisan is far better off than the middle-class householder, as the former has the power of paying as much or as little as he pleases within certain limits, while the latter has not.

8. All strikes, as it has been remarked, have a tendency to thrust up prices, and when prices once go up it is very hard to say when they will come down again, for the high prices are frequently maintained when there is no reasonable excuse to justify their maintenance. Strikes tend, moreover, in some cases to send trade out of the country, and by causing an increase in the poor-rate they too frequently increase the burden of the actual ratepayer, who at the best of times is heavily taxed.

Strikes raise prices.

9. The incomes of the clergy, professional men, clerks, and others who do not derive the money on which they live from actual trading, are, generally speaking, either fixed or very inelastic. Occasionally a professional man may make his fortune, but with most men in the grades of life that have been mentioned the annual income fluctuates but slightly, and if it tends to increase, as in the case of clerks in banks and in the civil service, the annual increment is but very small, and a maximum is at length reached, beyond which the income he enjoys is not likely to advance.

Incomes of clergy, etc., inelastic.

10. Now the question that we have to consider, and that most earnestly, is, *How can men in such a case best help themselves?* And to this the only answer worth having that can possibly be given is, *By learning to use their hands as well as their head!* By determining, in fact, to do at home many things which they have hitherto been accustomed to hand over to an artisan, and for which—to use a phrase far more expressive than elegant—they have had to pay through the nose. In short, let all who have the will to help themselves (and if the will to do is good the doing is well-nigh sure to be attended with success) determine to become—

Self-help possible and desirable.

Every Man his own Mechanic.

Yes, reader, mend your broken chairs and crippled furniture ; put fresh panes of glass into your broken windows ; do your own repairs as far as it is practicable, indoors and out of doors ; look after your own locks and fastenings ; make your own garden plant and appliances ; put up your own sheds, greenhouses, and garden buildings, and I will answer for it that if you check what you save on each job,

you shall find yourself in pocket at the end of the year merely through resorting to self-help.

11. Let us take a simple case of common occurrence, as for example, a broken window, and see, by comparing the cost of repairs when executed by a glazier on the one hand, and done by the householder himself on the other, how much may be saved by means of a little practical knowledge and self-help. **A case in point.**

12. We will first look into the cost of the work when the householder is his own mechanic. The man who lays himself out to do odd jobs of this kind will of course have at hand the tools necessary for carrying out the work, namely, a hammer, a suitable knife for hacking out or cutting away the hardened putty and fragments of glass still remaining in the window frame, and a putty knife. The first thing to be done is to clear the rebate in the sash-frame for the reception of the new pane of glass. The next step is to measure accurately the length and breadth of the aperture, including the rebate, and procure a piece of glass of the required size from any painter and glazier or oilman who cuts glass for those who may require it. A little putty must also be procured. Now supposing, for the sake of argument, that the glass measures 18 in. by 12 in., or, in other words, contains one and a half superficial feet, the cost of the glass will be 4½d., as the price of common Belgian glass for ordinary glazing purposes is 3d. per foot super. The cost of the putty may be reckoned at ½d., putty generally speaking being 2d. per pound, though it may be frequently purchased at the oilman's for 1½d. per pound. The expense, then, of putting things as they were before to the householder who can use his hands is no more than 5d. **Broken window—how to mend it.** **Cost of materials.**

13. But suppose, on the other hand, that a painter and glazier is desired to send a workman to mend the broken window. In the first place he may not have a man on the premises to send, and the householder must wait and his family suffer inconvenience, or patch up the hole with brown paper or a piece of pasteboard as best they can, until the job can be attended to. The mode of procedure will then be something as follows :—The workman will first come up and look at the window, and take the measurement for the new pane. He will then return to the shop, cut the necessary piece of glass, and come back to the house with the glass, some putty, and the tools that he requires, and put in the pane. Possibly the glazier's shop is a mile away from the house at which the repairs are to be done, and what with going and returning *twice* over **What the workman will do.**

the ground and putting in the pane, at least two hours will be taken up; for, it must be said, the workman as a rule never hurries himself, and his master has but little power to compel him to do so. All he can do if he finds that a journeyman is persistently long over his jobs is to discharge him, a remedy that may be as bad, if not worse, than the disease, as he may get another in his place who may be even more dilatory. Let us now look into the cost. For the materials used, the master will charge, for ordinary window glass, about 9d., or nearly double the prime cost to the householder if he does the work himself; and as a glazier is paid at the present time 9d. per hour for his time, 1s. 6d. must be added to the cost of the glass and putty, and, as the master always charges for his men's time at a somewhat higher rate than that at which they are paid, the householder will find when his bill is sent in that the job is charged at 2s. 6d., and he has got to pay just *six times as much* as he would have done if he had bought the materials and done the work himself.

Professional charges.

14. It must be understood that we are by no means finding fault with the charges made by the master, nor with the amount paid per hour to the workman, for "the labourer is worthy of his hire." Labour must be paid for, and should at all times be remunerative to him who performs it; and the master is entitled to interest on money paid out for materials and labour. The only thing to which objection can be taken in the case under consideration is that pretty nearly twice as much time was expended in doing the job as was necessary. If the workman had taken some glass and all his tools with him on his first visit to the house, just half the time taken up in walking backwards and forwards from shop to house and from house to shop might have been saved—for, as we have said, in this part of his work the British workman never hurries himself, for it is manifestly not to his interest to do so—and the householder need not have been charged more than 1s. 6d., or at the utmost 1s. 9d., for the labour expended and the materials used.

Labour must be paid for.

15. It is to be hoped that the above example has made it sufficiently clear that it is the cost of LABOUR which makes all building operations and repairs, be they what they may, so expensive to those who have to pay for them; and that, if a man has sufficient energy and determination to do such work himself as far as it is practicable, he will not only save a considerable sum in this respect, but also in the cost of materials, which, as it has been broadly shown, can be purchased at a far cheaper rate than that at which they are supplied by the master.

Building operations—why expensive.

Artisans' wages.

16. It will be well to pause awhile here and look at the wages which are paid in the present day to artisans and mechanics in the building trades. The prices given are those which are paid in the metropolis and its vicinity, where they are invariably the highest. In the country, prices rule somewhat lower, and they will even differ slightly in different parts of the country. It is safe, however, in calculating the cost of a job according to the number of hours that may probably be employed in it, to take London prices as given below for the basis of calculation. Again, when the cost of a job *per time* is under consideration, it will be as well to increase the estimate arrived at by half as much again, or even to multiply it by 2, as in course of carrying it out it will be found that many contingencies will happen to prolong the time employed in it that it were almost impossible to anticipate.

Cost of job per time.

Scale of wages.

17. The following is a full list of workmen employed in the building trades, and the rates of wages *charged by builders* per hour at the present time, compiled from the best authorities. The *prime cost* of wages per hour, that is to say, the wages paid by builders, ranges from 6d. for labourers to 8½d. for painters, 9d. for masons, bricklayers, carpenters, plasterers, and slaters, and 10d. for plumbers.

	s.	d.		s.	d.		s.	d.
EXCAVATOR	0	8	SLATE MASON	1	0	WIRE-WORKER ...	0	9½
BRICKLAYER...............	0	10½	Labourer	0	8½	Labourer	0	6
Labourer	0	7	PLASTERER	0	10½	PLUMBER	0	11
Fire-bricklayer	1	0	Modeller	1	2	Labourer	0	7½
Labourer	0	7	Labourer	0	7	GAS-FITTER	0	10½
Scaffolder	0	8	CARPENTER & JOINER	0	10½	Labourer	0	7½
MASON	0	10½	Labourer	0	7½	PAINTER	0	10½
Carver	1	1	SMITH	0	11	Grainer	1	3
Labourer	0	7½	Labourer	0	7½	Decorator	1	6
PAVIOR	0	10	ZINC WORKER............	0	10½	GILDER	0	10
Labourer	0	7	Labourer	0	7	GLAZIER	0	10½
SLATER AND TILER ...	0	10½	BELL-HANGER............	0	10½	Labourer	0	7
Labourer	0	7	Labourer	0	7	PAPER-HANGER ...	0	9½

Decorator's wages.

18. It must be understood that the decorator, on account of his artistic skill, is paid at a higher rate than the ordinary house-painter, while such work as graining in imitation of various kinds of wood, painting in imitation of marble, and writing letters of all kinds, also commands higher rates of payment, writing being paid for at per letter, according to size and manner of execution, and graining and marbling generally by the job.

Prices charged by builders.

19. The prices charged by builders and contractors for work of all kinds are framed according to the prices of the materials used and the labour employed, and will naturally vary in different parts of the country. Those who desire a more intimate acquaintance with the minutiæ of such matters than can be gained

from or given in the following pages, are referred to such works as Laxton's and Bevis's "Price Books for Architects, Builders, Engineers," etc., and Spon's "Architects', Builders', and Contractors' Pocket Book of Prices and Memoranda," in which every detail is given in a most complete and exhaustive manner.

Price books.

20. It may be argued that a man who aspires to be his own mechanic cannot possibly gain a sufficient knowledge of all or any of the various building trades to enable him to do the necessary work of construction or repairs in a workmanlike manner, and that even if he could do so he would never be able to find time enough to do all that may be wanted in house and garden from year's end to year's end. Now, as far as time is concerned, it may be pointed out at once that the most hard-worked man has his Saturday half-holiday and the Bank-holidays, to say nothing of the summer evenings when there is light enough for handicraft work even after 9 o'clock; and if these be not enough, he must—as people are often told to do who object that they can find no time for this, that, and the other—MAKE time. The genial Irish lyric poet, Tom Moore, has told us that

Every man has time for necessary work.

"The best of all ways to lengthen our days
Is to steal a few hours from night;"

and if the man who wants to make time would make it in this manner, stealing the hours from the right end of the night—that is to say, even at the risk of being put down as *Hibernior Hibernicis*, from the early morning—he would find the practice beneficial to health as well as pocket, and by steady continuance therein would not only lengthen his days but his years too. To burn the midnight oil in pursuit of book-knowledge seems to be a mistake; it is so, without any doubt whatever, in following up any handicraft or handiwork. For these, the time and sunlight of the early summer morning are eminently the most suitable.

21. But how, it may be further urged, is a man to obtain, first the knowledge, and next the practice necessary to do any handicraft-work even in a decent and respectable manner. An artisan has in most cases to spend a long apprenticeship before he can command full wages. This is true, but it is equally true that many an apprentice, when he has once learnt to handle his tools, does a day's work as fully deserving of a man's wages as the work that is turned out by an old hand. The chief thing to be done is to learn the uses of the different tools used in the trade, be it

Knowledge and practice, how to obtain them.

what it may, and how to handle them and keep them fit for use. Next to this, it is useful to watch any artisan when he is doing work on the premises, to see what he does and ascertain his reasons for doing it. It is wonderful how much useful trade-knowledge may be acquired in this way. Lastly, the theory and general *modus operandi* may be learnt from books, such as this; not that theoretical knowledge will make a man a good workman, but that it will assist him when he endeavours by practice to turn to account the lessons he has learnt from observation, and the practical teaching necessary to enable him to use his tools with effect.

22. It is good policy, then, for every man who seeks to do a little as a handicraftsman, to lay out a guinea or two in obtaining the services of any moderately skilled artisan, who, for such a sum, would willingly show the aspirant how to use his tools, and how to keep them in working order. Thus, for example, if a man desired to follow up carpentry, it will be beneficial to him in the highest degree to enlist the services of a joiner who will show him how to use his saw and his plane, and how to keep his saw fit for use by sharpening it with a file, and his plane and other cutting tools in proper condition by means of the grindstone and oilstone. If, again, he wished to be able to build a brick wall, he should get a bricklayer to show him how to prepare his foundations with spade and level, and how to put in the footings of his wall, and to raise it, course after course, so that its faces within and without, may be truly perpendicular, inclining neither to the one side or the other. Having once learnt *how* to do a thing, a fairly intelligent man will not require so very much practice to enable him to do such work as inclination or necessity may suggest, in a tolerably workmanlike manner.

Knowledge must be paid for.

23. Practical instruction in handicraft trades, or, in other words, technical education, is far too much neglected in English schools; indeed, there is great room to doubt if it be even attempted, much less carried out, in any in the manner in which it ought to be. Among the Jews, we know from St. Paul's own sketch of his life-history in the New Testament, it was the rule that every boy, whether gentle or simple, should learn some handicraft trade. The great Apostle of the Gentiles had accordingly learned tent-making in his youth, and his practical knowledge stood him in good stead in after life, when in his missionary work he frequently gained his daily bread by the labour of his hands, refusing to be burdensome to any of those, to win whom for Christ he had gladly, like his and our great Master and Example, become poor. In Germany the pupils

Technical education.

in large well-to-do middle-class schools have an opportunity, if, indeed, it is not compulsory on each, of devoting part of his time out of school hours to the acquirement of some handicraft trade; and the Prince Consort, following the praiseworthy fashion of his country, made this an especial feature in the education of the Heir to the British Throne and the junior members of the Royal Family. At present, far more time than is either necessary or healthful is spent in the school-room, which should be used as a lecture-room and a place for *imparting* instruction to the pupils, rather than as a place in which a certain number of hours are spent daily, partly in getting portions of certain text-books by rote, and partly in hearing the tasks thus committed, parrot-like, to memory, to be forgotten again some short time after. It is a pity that to every school of importance a range of workshops are not attached, in which every boy in the school may gain an elementary knowledge of one or more handicrafts. The practical hand-work would give more zest for the theoretical head-work of the school-room. To those who emigrate—and who can tell nowadays where he may pass his prime of life or end his days?—the value of a knowledge of carpentry, smith's work, painting, gardening, thus practically gained at school, would be inestimable; while to those whose lot it is to remain in the mother country, it would be equally desirable, as affording them the means of helping themselves by doing such handicraft work as they might be able to compass in house and garden, as they find daily wants and expenses continually increasing, while the income, out of which they must be provided as far as it is possible, remains entirely or very nearly at a fixed point.

Workshops attached to schools.

Practical knowledge, to whom useful.

24. If it be asked what branch of handicraft trade, or, to bring matters within a narrower compass, what branch of the building trade is most suitable and most useful for amateurs generally, and householders especially, it must be answered that a knowledge of carpentry and joinery will be found by far the most desirable. Next to this, it is necessary to know something about painting and glazing, which comes fairly within the province of the amateur. Collaterally with these useful arts paperhanging may be mentioned. It is unlikely that a man will do much smith's work, but even in this it is possible for an amateur to do something, and a slight acquaintance with the arts of of brazing, soldering, and working in metals will enable a man to make propagating cases that shall do him good service, and apparatus for heating a small greenhouse, if he have one, at little expense, even if

Choice of handicraft trade.

Carpentry most desirable.

he still leaves it to the peripatetic knife-grinder and tinman to stop up holes in leaking coffee-pots and saucepans, and to renew the damaged bottoms of colanders and gravy-strainers. Wire-working, again, is a useful, and by no means unattractive pursuit, inasmuch as, with some slight knowledge of the methods employed, it is possible to make a birdcage or a fire-guard, or to construct a strong but fine wire trellis-work for climbers, or to make defences against the ravages of birds for peas and other growing seeds.

Wire-working.

25. Bricklaying and masonry are trades that possibly an amateur will not meddle much with; but some slight acquaintance with the principles of each, and the materials employed, is desirable, even if it be for no other or better purpose than that of giving an eye to any workman who may be employed in this way on the premises, in order to see that he is doing his work in a workmanlike manner, that he is using proper materials, and that he is not wasting his time—a thing which no workman who has any self-respect will do. It is, however, quite as well to be able to know oneself how to set a stone or step that has become loose by one cause or another, in cement, and how to prepare the cement for the work; and know in what proportions sand and cement should be mingled for the purpose of making a suitable composition for fixing the step once again, so that it may remain immovable in its proper position. Lastly, a knowledge of excavating in all its branches is attended with advantage. In the term "excavating" a far greater variety of work is comprised than appears upon the face of it at first sight. It means far more than digging or hollowing out a pit, as for a well or a trench, or for the foundation of a wall. It embraces these, it is true, but it also implies a knowledge of the manufacture—if we may use the word—of concrete, and the purposes to which it is put, of making garden walks and paths and of levelling, so far as it may be applied to the construction of drains for carrying off the surplus water from the soil of the garden, or even from a stable or pigsty, and the laying of drain-pipes for this purpose. It also gathers within its wide embrace a knowledge of the method of making tar paving and burning clay into ballast—processes which will often be found extremely useful in the garden.

Bricklaying and masonry.

Setting stone or step.

Excavating.

26. Carpentry and joinery, twin branches of a single art as they may be called, embrace together a far wider field than any of the subjects that have just been mentioned; and an explanation of all that can be done in them, and the different tools and machines that may be used in their various processes, demands as much

Carpentry and joinery.

space as a description of all the other arts pertaining to the building arts put together. We must therefore confine ourselves at the present time to a consideration of carpentry and joinery only, reserving for another occasion an inquiry into the processes involved in excavating, bricklaying, masonry, painting, glazing, paperhanging, and other branches of the building trade—taking occasion, in the third and concluding part of this work, to dwell on the practice of these allied arts as exemplified in the construction of many things that the householder finds useful every day, either within doors or out of doors.

Carpentry, why attractive to amateurs.

27. Of all the constructive and manipulative arts that are grouped together under the wide and comprehensive name of the Building Trade, carpentry in all its varied branches—we are now using the word carpentry in its general and not in its restricted sense, which will be explained presently—is the one that presents the most attractions to amateurs. The reason is that it is a clean trade, and the one that is found to be most generally useful. When a servant has to sweep up a room after a carpenter has been at work in it, either fixing something or doing some necessary repairs, she seldom makes a trouble of her task, but in nine case out of ten speaks of the débris and shavings that are littered about on the floor as " clean dirt "—that is to say, stuff which imparts no soil or stain to boards or carpets, and requires nothing but the action of the sweeping-broom or carpet-brush to remove it. An amateur carpenter, in fact, may go to his little workshop, either within or without the house, as the case may be, and after working as long as he will in his ordinary everyday clothes, require nothing more than a wash and brush up to render himself presentable in the parlour or drawing-room.

Amateur's working dress.

28. Far otherwise is it with other branches of the building trade, as, for example, smith's work, soldering, and brazing, which involves the use of heat in one form or another, and contact with the soot and dirt engendered by combustion and the materials that are used in the forge and furnace. The clothes of the amateur, unless a special dress is kept for the workshop, should be protected at least by a loose " slop," or jacket of canvas, and a canvas apron ; it need scarcely be said that a leather apron covering the chest and legs will afford far more protection from sparks, soot, and grease than one of a textile material. When engaged in painting or glazing, the amateur should wear a canvas jacket and apron ; and for excavating, and all work which involves digging, as well as for bricklaying, masonry, mixing and handling concrete, and all dirty work of this kind,

it is desirable to wear a canvas slop, trousers of stout fustian, and stout lace-up boots, which will be all the more serviceable if the soles are studded with broad flat-headed nails.

29. It may be useful to pause a moment and inquire into the meaning and general application of the terms "working man," "workman," "artisan," and "mechanic." It is the custom to apply the expression "working man" to workmen exclusively—that is to say, to men who work with their hands at handicraft trades. When used in this restricted sense, and as the rightful designation of the artisan or labouring classes, the word is altogether misapplied. The man who works with head and brain is as much a working man as the man who works with his hands; and when properly employed, this term includes all workers, whether they be head-workers or hand-workers. The premier, the man of letters, the merchant, the clerk, and the trader are as much working men as the artisan or labourer. To the last-named classes the term "working man" will never be applied in these pages, for the reason that they have no exclusive right to it. Men and women who are engaged in handicraft trades and manual labour are workmen and workwomen. Long ago the term "artisan" was applied to any one who professed and practised some liberal art: the word, in fact, was synonymous with artist. In the present day, the word "artisan" means one who is trained to manual dexterity in some mechanic art, mystery, or trade —a handicraftsman. It has been justly remarked that "a portrait painter is an *artist*; a sign painter is an *artisan*. The occupation of the former requires a fine taste and delicate manipulation; that of the latter demands only an ordinary degree of contrivance and imitative power. The word *artificer* neither suggests the idea of vulgarity which attaches to the term *artisan*, nor the ideas of refinement or peculiar skill which belong to the term *artist*." A "mechanic," again, is "one who works with machines or implements, a workman or labourer other than agricultural: more specifically, one who practises any mechanic art—one skilled or employed in shaping and uniting materials, as wood, metal, etc., into any kind of structure, machine, or other object requiring the use of tools or instruments." Those who do work of any kind, whether with head or hands, are entitled to be called and regarded as *working men*, but the special names which pertain to those who work at handicrafts are *workman*, *artisan*, and *mechanic*. The appropriation of the terms "working classes" and "working men" to these exclusively has given colour to an idea that is unfortunately very prevalent among mechanics,

Working man: meaning and application of term.

Artisan, artificer, and artist.

operatives, and labourers, that they are the only people in the world who actually do work, and that bread-and-butter drops into the mouths of all who happen to be above them in social rank without any trouble.

Social distinctions nothing.

Nevertheless, social distinctions are nothing. God respects no man's person, and regards no man's social status; every man or woman has real work to do in this world in that state of life to which he or she has been called by God as a state of probation and trial; and we must all look rather to *how* we are doing the work that has been entrusted to us, than to what the work may be, and how it may be regarded in the estimation of the world.

30. When carpentry and joinery are spoken of together, it is possible that the two words may not convey a distinctive meaning to every one who hears or reads them, and it may be serviceable to point out here in what the difference really consists.

The carpenter and his work.

A carpenter, speaking generally, is an artificer who works in timber, a framer and builder of houses and ships, as far as wood may be employed in their construction. "The *carpenter*," says Tomlinson, "frames and puts together roofs, partitions, floors, and other essential parts of the building. The *joiner* only commences when the carpenter leaves off, by supplying and fitting stairs, cupboards, furniture and other parts necessary, but not essential to, the building."

The joiner and his work.

The chief tools of the carpenter, properly so called, are the saw, the axe or hatchet, the adze, the hammer, and the chisel; the joiner, in addition to these, requires planes of various kinds to impart a smooth surface and relief, by mouldings of various kinds, to his work. Carpentry, then, means the art of cutting, framing, and putting together timber in the construction of buildings, or an assemblage of pieces of timber connected by being framed together, as the pieces of a roof, partition, floor, etc. Joinery, on the other hand, is the art or work of a joiner; and a joiner is a mechanic who does the woodwork in the covering and finishing of buildings, or whose occupation it is to construct things such as tables, chairs, boxes, etc., by joining pieces of wood together. The artisan who makes furniture of a more elaborate description is usually called a cabinet-maker, the term "cabinet" being applied to a piece of furniture consisting of a case or box furnished with doors and drawers.

Derivation of these terms.

31. The words carpentry, carpenter, joinery, and joiner have come to us from the Latin through the French. Thus, the English term carpenter is derived directly from the French *charpentier*, a slight alteration of the old French *carpentier*, which is

closely akin to the Latin *carpentarius*, a wheelwright, or maker of waggons, from *carpentum*, a car, or waggon. The Italian term for a wheelwright or any worker in timber is *carpentiere*. The English term "joiner" comes from the French *joindre*, to join; which, in its turn, is derived from the Latin *jungere*, to join or yoke together, as horses are yoked to a car. The word "cabinet" is a diminutive of "cabin," which finds its origin in the Welsh *caban*, or French *cabane*, a booth, or hut, akin to the French *gaban*, and English *gabardine*, a cloak, or outer garment; all the words implying shelter or covering of some kind. Thus, the term "cabinet" implied a close place where anything of value might be deposited for safe keeping; and as the construction of such chests and boxes implied a considerable degree of skill in the artificer, the appellation cabinet-maker was in time extended to all who were employed in making household furniture of the better kind.

Carpentry, how divisible.

32. It will be convenient for the purposes of this work to consider carpentry and joinery as separating naturally into two divisions, which may be described as (1) *Simple Carpentry and Joinery*, (2) *Ornamental Carpentry and Joinery*: the first comprising all operations necessary for preparing pieces of wood and framing and joining them together, which may be performed by the ordinary tools of the carpenter; the second, decorative work, and all such working in wood as may require the aid of special machinery of some kind or other to produce it. We shall leave the consideration of all branches of ornamental carpentry to another section of "Every Man his own Mechanic," confining ourselves in this section to a review of the materials and tools used in simple carpentry, and the various processes by which separate pieces of timber may be securely put together.

CHAPTER II.

THE VARIOUS WOODS USED IN CARPENTRY, ETC.—SPECIFIC GRAVITY AND STRENGTH OF TIMBER.

Things that the amateur must know—Working drawings—Classification of woods—Deal most frequently used—Alder Wood—Ash: its uses—Hungarian Ash—Beech: its uses—Beech: its varieties, etc.—Boxwood—Spanish box—Chestnut—"Tunbridge ware"—Deal, or Pinewood—Larch—Ebony: its varieties and uses—Black Ebony—Elm: its uses—Holly Wood—White Holly—To clean Holly Wood—Lime, or Linden Tree—Uses of Lime Wood—Mahogany—Oak—Pollard Oak—Medullary rays in Oak—Poplar Wood—Rosewood and its uses—Sycamore—Walnut Wood—Black Walnut—White Walnut, or Butternut—Willow and its uses—Collection of various woods useful and desirable—Woods used in the arts, etc.—Acacia, or Locust Tree—Almond Wood—Aloes Wood, etc.—Amboyna Wood—Kiabooca wood—Apple Wood—Beam Tree—Bird's-eye Maple—Botany Bay Wood—Cam Wood—Camphor Wood—Canary Wood—Cedar: its varieties—Cedar Wood—Cherry Wood—Cocabola Wood—Cocus Wood—Coral wood—Coromandel Wood—Dogwood—Elder—Fusci—Greenheart—Gumwood—Hawthorn—Hickory—Hornbeam—Ironwood—Kingwood—Laburnum—Lancewood—Lignum Vitæ—Logwood—Nettle Tree, or Lote—Olive Wood—Partridge Wood—Pear Wood—Plum Wood—Pomegranate Wood—Red Satinwood—Rosetta Wood—Sandalwood—Satinwood—Service Tree—Teak Wood—Violet Wood—Tulip Wood—Whitewood—Yew, and its uses—Knowledge of all woods used in carpentry desirable—Best timbers for various uses—Weight of wood per cubic foot—Table of weights of woods—Cubic feet of various woods to ton—Weights given approximately only—Specific gravity—To determine specific gravity—To determine weight of a cubic foot—Buoyancy of woods—Strength and breaking strain—Theory of carpentry—Strength of wood—Strength increased in proportion to width and depth—Why joists are deep—Power of resistance: how modified—Instantaneous breaking weight—Breaking weight: how found—Breaking weight in centre of beam—Formula for breaking weight—Tables of breaking weight for foot length—Deduction of breaking weight for other lengths—Rule in calculating strength of timber—Intimate acquaintance with theory of carpentry not necessary for amateurs.

Things that the amateur must know.

33. BEFORE entering on a description of the different tools and processes employed in carpentry, it will be well to consider the various kinds of wood that are used, and the purposes for which each is specially adapted. Experience will show that wood which is admirably fitted for one kind of work is by no means suitable for another. The prices, too, of different sorts of wood differ as much as their qualities, and it is desirable that the amateur artisan should become acquainted with these to some extent,

that he may know what he is about when he is making purchases of his timber merchant. A knowledge of the prices of the different kinds of wood used in building and furniture making will also be useful to him in other ways. For example, if he intends to put up even so unambitious a structure as a weather-boarded shed, he can, after making his plans and working drawings, calculate to a nicety the quantity of wood that will be wanted, and its cost at the timber yard; and if he finds that the job will run into more money than he expected, he can modify his plans and the mode of structure to suit his pocket.

34. Instruction will be given in a future chapter with regard to the preparation of working drawings, but we cannot refrain here from urging strongly on the amateur artisan the necessity of preparing careful plans and working drawings to scale of any piece of work that he is about to take in hand, whether large or small, before he attempts to put it in hand. It is an old but true saying, that "Well begun is half done," and the worker in wood or stone or any other building material will be led to appreciate its truth and wisdom when he finds how helpful the making of correct and careful plans and drawings will be to him in the actual performance of the work in question. The whole mode of procedure—what he has to do and how he must do it—will be clearly fixed in his mind before he even touches the material which he is about to work up into the desired form or object, and he will always find the execution of the work to be quicker or slower, according to the extent to which he has previously worked out his plans in his mind, and committed them to paper.

Working drawings.

35. It will be convenient to treat of all kinds of wood used in ornamental as well as in ordinary carpentry in this section of "Every Man His own Mechanic," and to divide the various descriptions of wood into two classes or groups, including in the first group all kinds which the amateur mechanic must of necessity employ in his work, and many others that are used every day by cabinet-makers and turners, but which the amateur, like the house carpenter and joiner, may very seldom, if ever, be called on to handle, unless he proceeds to the higher and more ornamental branches of the art. In the second group will be given other kinds of wood not commonly used in this country, unless in furniture making, etc.; but which are especially valuable for this purpose, or otherwise possess a commercial value in connection with one or other of the industrial arts.

Classification of woods.

36. Of all the different kinds of wood that are comprised in the first group, deal, or pine, is that with which the amateur will be most fre-

quently employed, and of which it is most necessary that he should know the prices and sizes at and in which it can be procured at the timber yard. These will be fully entered into presently. At present it is only sought to convey some idea of the nature of each kind of wood, and the purposes for which it is or may be used.

Deal most frequently used.

VARIOUS KINDS OF WOODS MOST GENERALLY USED IN ORDINARY AND ORNAMENTAL CARPENTRY.

37. The ALDER TREE is found in all parts of Europe, Asia, and North America, and ranges in height from twenty to forty feet. It is a hardy deciduous tree, and is found chiefly near the banks of rivers, and in moist situations. The wood is fine and close-grained, and of a reddish-yellow colour ; the knots are frequently lined in a beautiful manner. It works very smoothly, and is much used by turners and pattern-makers. For pattern-making, curves of too small a radius to be made of ash, and bent to shape, are cut out of Alder.

Alder Wood.

38. The ASH is a hardy deciduous tree, found generally in northern latitudes. In colour the wood is greenish white when young, but the grain of timber cut from old trees is often dark and beautifully marked. When in this condition it is frequently used by the cabinet-maker. Its toughness, elasticity, and closeness of grain render the wood useful for making the frames of carriages, agricultural implements, felloes of wheels, etc. Hammer-handles and billiard-cues are frequently made of Ash, as well as the handles of croquet-mallets, and it is much used by coopers. It admits of being bent almost double without snapping, and on that account it is well adapted to be used for curved work, if the sweep be not too small.

Ash: its uses.

FIG. 1.—ASH TREE.

39. There is a variety known as HUNGARIAN ASH, which is valuable and suitable as a groundwork for marquetry. The value of the wood varies in accordance with its markings, some

Hungarian Ash.

specimens being so beautifully veined and streaked as to be worth double the price at which ordinary pieces can be procured. The grain is not very close, but disposed in various lines, soft in some spots and hard in others. It is a difficult wood to cut, and is better adapted for backgrounds than for sawing as fret-work. The most convenient way of using it is veneered on other woods, similarly to bird's-eye maple.

40. The Beech is a hardy deciduous tree, also found in northern latitudes. It abounds in Buckinghamshire—a county which was so called from the Beech trees which covered, and, indeed, still cover, the sides of its hills. The colour varies; it is mostly light or whitish brown in tint, but is found in all shades of

Beech: its uses.

Fig. 2.—Beech Tree.

brown, deepening at times to black. This difference in colour is ascribed by Tredgold to the influence of the soil. The wood is fine and straight-grained, somewhat brittle, and easily worked. The grain resembles that of mahogany, and it is often stained to represent it. It is used in the manufacture of furniture, tables, beds, and chairs being made of it; indeed, the manufacture of beechen frames for cane-seated chairs forms one of the principal industries of Buckinghamshire. It may be stained to imitate ebony and rosewood as well as mahogany.

The framework of machinery, planes, chucks; the handles of tools, and wooden cogwheels are generally made of Beech.

FIG. 3.—BIRCH TREE.

Birch: its varieties, etc.

41. The BIRCH is a forest tree of graceful appearance, found in cold and temperate regions, and on elevated situations, such as the sides of mountains in warmer countries. The wood is white, firm, and tough, and is used especially in northern countries for making wheels, casks, tubs, and turnery. In North America the wood of the Black Birch is considered valuable for cabinet-making and household furniture, and in the United Kingdom it is often used for bedsteads, small tables, etc.

Boxwood.

42. The variety of BOX that is best known in this country is the short shrubby plant frequently used as border-edging. Box trees which range in height from eight to thirty feet are rarely met with in Britain. It flourishes in Turkey, whence the finest boxwood is procured. It is exceedingly useful on account of its solidity and hardness, and the closeness of the grain. It is much used for lathe chucks, and in common turnery; the amateur artisan, indeed, will chiefly require this wood for boxes, draughtsmen, chessmen, and other fancy articles that he may wish to make. It may be stained black to imitate ebony, and will take a high polish. The closeness of the grain also makes it particularly suitable for the purposes of the engraver on wood and the mathematical instrument-maker.

FIG. 4.—BOX TREE.

Spanish box.

Spanish Box is similar in colour and closeness of texture to Turkish Box, and works well. It is used by turners, and by musical instrument makers for making flutes, clarionets, flageolets, etc.

43. The wood known as CHESTNUT is derived from two widely different kinds of trees—the Horse Chestnut and the Spanish or Sweet Chestnut, of which the former belongs to the natural order of *Sapindaceæ*, or Soapworts, and the latter to that of the *Corylaceæ*, or Marshworts, to which the beech also belongs. The similarity of name must not lead the reader to imagine that these trees are in any way allied. The white brittle wood of the Horse Chestnut is used by turners in making the fancy goods usually known as "Tunbridge ware." The wood of the Sweet, or Eating Chestnut, which is sometimes planted in Devonshire, is hard and durable, and beautifully grained and variegated. Furniture is sometimes made of it, and it is used with effect for decorative purposes in building.

Chestnut.

FIG. 5.—HORSE CHESTNUT TREE.

"Tunbridge ware."

44. The general name of DEAL, or PINEWOOD, is given to the timber that is yielded by a great variety of cone-bearing trees, although the deal or pinewood cut from different trees varies considerably in quality and general utility. Deal may be broadly distinguished as Red or Yellow Deal—for the names are indifferently used—and White Deal. In one kind, the ground colour of the wood is yellow, diversified with markings of pale red; in the other kind, the wood is of a whitish colour, whence its name. White Deal is obtained from the Spruce Fir, and Red or Yellow Deal from the Scotch Fir and Pitch Pine. The difference

Deal or Pinewood.

FIG. 6.—PINE TREE.

in the two kinds of wood is this: the grain of the Yellow Deal is generally very straight and free from knots, and is very durable, though it is soft and easily worked. This renders it peculiarly appropriate for all building purposes, whether in the construction of houses or ships. The great height and straightness of the pine renders it well suited for the masts of ships; and when stained and varnished the timber presents a handsome appearance for joiners' work in houses. White Deal is harder and not so straight-grained as Yellow Deal, and it is generally full of knots. The variety known as Silver Fir is used for flooring, and also in the manufacture of household furniture. The Larch furnishes a durable wood for outdoor purposes, especially on farms and homesteads. Varieties of Deal are generally distinguished by the names of the countries from which they are imported. The best kinds come from Sweden and Norway, Russia, and America. In purchasing timber the amateur must be careful to specify the kind of Deal that he requires, whether White or Yellow. To be acquainted with the difference in the appearance of the two kinds will prove of advantage to him in making the selection.

Larch.

FIG. 7.—LARCH TREE.

Ebony: its varieties and uses.

45. EBONY is a fine, heavy, and compact-grained wood, which can be worked without difficulty. It is much used by turners and mathematical instrument-makers, for mosiac and cabinet work, and in the manufacture of musical intruments; for example, the black notes in the keyboard of a piano are of Ebony. Ebony is distinguished as Green and Black. Green Ebony comes from the West Indies, and is so called from the colour of the heartwood, which is brownish green. It is frequently used in marquetry. Black Ebony is brought from Africa, the East Indies, and the Mauritius. African Ebony is a serviceable wood, and stands well, but the colour is indifferent, and the wood porous. The Ebony from the Mauritius is very hard, of fine close grain, and of a deep black colour, and being the best of the three is the most expensive. For ordinary work the East Indian Ebony is good enough, though it is inferior to that of the Mauritius in hardness and depth of colour.

46. The Black Ebony of the Mauritius and the East Indies affords the best and most direct contrast to white holly in marquetry. Sawing Ebony is a somewhat dirty business, as the dust soils and blackens everything on which it falls, and especially that on which it is rubbed. This material cuts clear and fine as horn, and therefore for marquetry its use is highly essential. It will not warp readily, but is apt to split under changes of temperature; its want of elasticity renders it inclined rather to break than bend; but its fine close grain admits of a magnificent polish, or even oiling. As it is seldom more than six inches wide, only small articles can be made of it in one piece, though, to compensate for that, it is the best wood of all for trinkets, small crosses, chains, bracelets, etc. It can be made smooth with a tool known as the cabinet scraper, but the quickest and least laborious mode of shaving it down is by submitting it to the action of a planing machine.

Black Ebony.

47. Elm is the wood of a lofty and handsome forest tree, well-known in Great Britain, which thrives best and attains its greatest height and growth in moist situations. Indeed, it is said that when the Elm flourishes in any particular spot, it is a sure indication that the locality is too damp to be desirable as a situation for a dwelling-house. Elm-wood will stand the wet for almost any length of time without decaying: it is therefore useful for all purposes in which immersion under water or exposure to moisture is necessary. It is very tough, cross-grained, and difficult to work, and it takes much labour and force to split it, which renders it suitable for the naves of wheels, etc. It is

Elm: its uses.

Fig. 8.—Elm Tree.

reddish-brown in colour, the heartwood being considerably darker in tint than the sapwood. Elm planks are used for the cheaper kinds of coffins, and in the western counties the trunks of small Elms, when bored, are used as pipes for conveying water from a spring or running stream into such places as back kitchens.

Holly Wood.

48. The wood of the HOLLY cannot be obtained of any great size in the United Kingdom, as those who are acquainted with the Holly Tree can readily understand. It is beautifully white, hard, close-grained, and durable. For these reasons it is very useful for turning, carving in wood, and inlaying. The Holly attains considerable height and growth in America, and broad planks or sheets of wood, suitable for fret-cutting and marquetry, can be sawn from American holly trees. It should be said that the Holly of America is a different species to that of Europe, the former being the *Ilex opaca* of botanists, and the latter the *Ilex aquifolium*. The wood obtained from the American holly is known as *White Holly*, being pure white—more so than the generality of ivory—and quite tough. The whiteness is due to a particular mode of seasoning, and subsequent exposure gives it a mellow creamy tint. The grain is very fine and close, and does not readily absorb foreign matter. It may be protected by a coating of bleached shellac, but the general effect of this material is injured, if not entirely spoilt, by any preparation that tends to impart to it a shiny appearance. The wood is apt to split and warp unless seasoned with care and kept in a dry place. It is hard and difficult to work, and smoothness of surface is best obtained by planing it with a planing machine. When White Holly gets very dingy it may be easily cleaned with a bit of chamois leather dipped into clean dry Paris white; and as the wood is of

White Holly.

To clean Holly Wood.

FIG. 9.—LIME TREE.

very close grain, its whiteness may also be restored by rubbing it very carefully with very fine sand-paper.

49. The Lime, or Linden tree, is generally planted for ornamental purposes, and is often placed in rows on either side of a broad street or roadway, or pruned and trained in such a way as to form a dense screen between a dwelling-house and the roadway, the trees being set tolerably close together and the principal branches interlaced or brought into close proximity. The wood, though of a close grain, is soft and easily worked. It is very free from knots, and is used in turning and carving in wood, for making musical instruments, and for various ornamental purposes. One of the most famous thoroughfares in Berlin, *Unter den Linden*, takes its name from these trees. The wood of the American Lime or Linden Tree is generally known as Bass Wood.

Lime, or Linden Tree.

Uses of Lime Wood.

50. The wood called Mahogany, which is now so much used in making every description of household furniture, and in the joinery of the better class of houses, shop fronts, etc., although known in England, was not considered valuable for the purposes to which it is now applied until after the year 1720. There are several sorts of this ornamental and useful wood, which is brought mostly from the West Indies and Central America. Another kind is brought from Gambia, in Western Africa. West Indian Mahogany is generally distinguished as Spanish and Honduras. Spanish Mahogany is brought from Cuba and St. Domingo, and other West Indian islands. It is darker in colour and of a closer grain than Honduras Mahogany, which is cut on the mainland of Central America. Spanish Mahogany is imported in logs about ten feet long and from twenty-four to twenty-six inches square. Honduras Mahogany is generally sawn into planks of considerable thickness, and the trees are so large that these planks have been known to measure six or seven feet in width. It takes a capital polish. The better sorts are used by the joiner, the cabinet-maker, and the ornamental turner. The inferior kinds are in demand with the pattern-maker, for particular patterns, in consequence of its not being affected by damp or heat. It holds glue the best of all woods.

Mahogany.

51. Oak. The best Oak timber in the world is grown in Great Britain, from whose forests, until iron came so much into use for ship building, all the Oak was derived for the splendid fleets which secured for this country the sovereignty of the seas. Although the grain is somewhat open—too open, indeed, for the purposes of the turner—the wood is extremely hard and durable, but difficult to

Oak; Pollard Oak.

work, and apt to take the edge pretty quickly off the workman's tools. The wood is dark in colour and susceptible of a high polish. It is much used in house-building, for houses of the better class, for floors, staircases, doors, the panelling of rooms, etc., and for tables, chairs, sideboards, and other pieces of household furniture. Pollard Oak, which presents a beautiful variegated surface, is valuable for decorative furniture. The spokes of wheels are usually made of Oak; and much, if not all of the carved work in cathedrals and churches and many ancient dwelling-houses are wrought in this material, which is in consequence most valuable to the carver in wood. The broad lustrous stripes that give such marked variety to the surface of an oaken panel is owing to the exposure of a greater or less space of the *medullary rays* which radiate something after the manner of the spokes of a wheel from the girth or centre of

FIG. 10.—OAK TREE.

Medullary rays in Oak. the heartwood to the bark, as shown in fig. 11, which represents the section of an oak tree. The red lines in deal are due to the lines of demarcation between the concentric circles, which are supposed to denote each a year's growth of the trunk. These concentric circles are shown in fig. 12. They will readily be recognised on looking at the end of a deal plank. When planks used for flooring are cut close to the centre of the tree, the layer of wood in the middle of the plank, which is very thin, is apt to wear up and split off, often causing injury to the hands of servants and charwomen, to whom the duty of scrubbing the floors may fall, through the splinters that are left projecting from the ragged surface of the board. Sometimes such a layer may be stripped up for the distance of some feet, like a ribbon.

FIG. 11. SECTION OF OAK.

FIG. 12. SECTION OF FIR.

52. POPLAR. These thrive best in a deep moist, loamy soil, but though they do well in damp situations, or near running water, proximity to stagnant water does not suit them. The wood is white, soft, and brittle, and chiefly used in the manufacture of children's toys. The softness of the wood causes glass grinders and lapidaries to use horizontal sections as polishing wheels. The wood of the poplar is not liable to shrink, warp, or swell. The fret-sawyer will find it useful for backgrounds, linings, and veneered work.

Poplar Wood.

FIG. 13.—POPLAR TREE.

53. The best ROSEWOOD is brought from Rio Janeiro, in Brazil; inferior qualities are imported from the East Indies and the Canary Islands. It derives its name from its colour, in which lighter and darker tints of rose-red are commingled. It is hard and difficult to work, but when brought to a good surface and well polished, it looks extremely well. It is used by the cabinet-maker for ornamental furniture, and by the turner. It is also useful for inlaying and veneering. The knots that occur in it tend to diversify the surface, and can be turned to good account by a skilful workman. The wood contains much resinous gum, and on this account it is difficult to saw when used for fret-work. This hindrance, however, may be overcome by slightly oiling the saw blade now and then in order to lessen the friction. There is an African variety beautifully marked, and bearing a strong resemblance to black walnut, which is free from the resinous gum that is so abundant in ordinary Rosewood.

Rosewood and its uses.

54. The SYCAMORE is indigenous to the British Isles, and bears some resemblance to the plane tree in its manner of growth and broad leaves. The wood is very soft, and easily worked, and is useful for inlaying and any other purpose in which whiteness is a desideratum

Sycamore.

55. The wood of the WALNUT is extremely useful and valuable, and is used in the arts for many purposes, of which not the least important is that of the manufacture of ornamental furniture. In olden times it was as much used for this purpose as in the present day, but after the introduction of mahogany and rosewood, walnut went out of fashion, and for some time was only used for making gun-stocks, etc. During the last thirty or forty years, however, it has again come into favour, and is now greatly in demand for dining and drawing-room suites, tables, chairs, couches, and every description of ornamental household furniture, for which it is well adapted by the fineness of the grain, its capability of taking a high polish, and the extreme beauty of the wood, which is of a greyish brown, richly diversified with streaks and veins of black running in all directions. Its only drawback is in its want of density, which renders it liable to injury from blows and rough usage. It is as useful to the turner as to the cabinet-maker, and works well in the lathe. It is desirable to get walnut wood from old well-grown trees, for the older the tree the more beautiful and diversified are the markings of the wood.

Walnut Wood.

56. For fret-sawing, and all kinds of cabinet work, the wood known as BLACK WALNUT is the most suitable. Unless well seasoned by kiln-drying, or some similar process, it is apt to warp and split. It will take a beautiful polish, and is susceptible of more variations in that respect than any other, and still look well. Plain oiling seems to harden the fibre, and a dead polish will often show better in the work than though it shone like a mirror. This wood ought never to be varnished, for it gives a common look to the article, and never fails to bring out the grain.

Black Walnut.

57. The WHITE WALNUT, known in the United States as the *butternut*, is a pretty wood, but soft. It cuts clean, and is adapted for many kinds of work, which, however, must not be delicate in design. It has the same grain as Black Walnut, stains well, and shows oiling to advantage.

White Walnut, or Butternut.

FIG. 14.—WILLOW TREE.

58. WILLOW. The Willow Tree flourishes on the banks of rivers and

in moist situations. The wood is white, or yellowish white, and tough. In this country it is chiefly known as the wood of which cricket-bats are made. When split into strips, it makes strong and serviceable hoops for small casks and tubs of every description.

Willow, and its uses.

59. Such are the various kinds of wood that are most commonly used in building and the constructive arts, and although the amateur artisan may have occasion to use but a very limited number of them, it is as well that he should know their qualities and uses. Indeed, if it be possible, it is desirable for the amateur to make a collection of as many kinds of wood as he possibly can, exhibiting their appearance, when sawn only, when worked to smoothness by means of the plane, and when stained and varnished, or polished. It would give him a valuable insight into the texture and capabilities of different kinds of wood, and would help him to experience, if he should ever take to inlaying, or the manufacture of parquetry, marquetry, etc.

Collection of various woods useful and desirable.

FIG. 15.—LOCUST TREE.

60. In addition to the woods already enumerated, there are several other kinds that are used in the arts, and even in the manufacture of ornamental furniture. A brief catalogue of these, and the purposes to which they are turned, may be desirable, if not so useful as the list already given, and for this reason it is inserted here.

Woods used in the arts, etc.

VARIOUS KINDS OF WOODS OCCASIONALLY USED IN THE ARTS AND IN ORNAMENTAL CARPENTRY.

61. The wood of the ACACIA, or LOCUST TREE, is a dark-coloured wood, bearing some resemblance to mahogany. It is brought from India, the West Indies, and the tropical regions of Africa.

Acacia or Locust Tree.

62. ALMOND WOOD is a very hard, dense wood, something like

lignum vitæ. It grows in the north of Africa, and parts of Asia and Europe bordering on the Mediterranean. It is used for the teeth and bearings of wooded cog-wheels.

Almond Wood.

63. ALOES WOOD, CALEMBEG, or GREEN SANDALWOOD, is a wood of a greenish colour, resembling Sandalwood in texture, and growing in tropical countries. It exhales a slight perfume, especially when cut or bruised.

Aloes Wood, etc.

64. AMBOYNA WOOD is a beautiful and valuable wood of diversified appearance, brought from the Eastern Archipelago, and deriving its name from Amboyna, one of the Moluccas or Spice Islands. It is used in inlaying, and may be made serviceable for veneering. It is sometimes called *Kaibooca* wood. It has the appearance of being the excrescence or burr of some large tree, being only obtainable in slabs from three inches square, to twenty by twelve inches. It is tolerably hard, and full of small curls and knots. The colour varies from orange to chestnut brown, and sometimes reddish brown.

Amboyna Wood.

Kaibooca Wood.

65. The wood of the APPLE is close and hard in texture, and of a rich reddish-brown tint. It is useful in turning, and cuts well for wooden screws. Large letters for printers' posters may be cut from this wood, and rulers for ordinary use are frequently made of it.

Apple Wood.

66. The BEAM TREE is a tree akin to the apple and pear, whose wood is useful for naves and axletrees of wheels, small cog-wheels, and similar parts of machinery. It grows in the United Kingdom, and is usually called the White Beam Tree.

Beam Tree.

67. BIRD'S-EYE MAPLE is a fine variety of Maple, brought chiefly from Prince Edward's Island in North America. It is yellowish in colour, diversified with red streaks and dark spots, with a lighter ring round them, from which it takes its name. It is chiefly used for making picture-frames, and is susceptible of a high polish. When used for picture-frames it is of course veneered on some other wood, and this tends to keep it from warping and splitting, which it is otherwise very apt to do. Being a close-grained, gritty wood, it is difficult to work with a handsaw, and requires careful skill, even with a treadle-machine, when cutting fret-work from it, as the small knots drag on the saw, causing it to run unevenly.

Bird's-eye Maple.

68. BOTANY-BAY WOOD, which is also called Beef Wood and African Black Wood, is a dense, hard, heavy wood, intensely black in colour. It is chiefly useful for ornamental turning, its extreme hardness rendering it capable of being ornamented

Botany Bay Wood.

with any pattern, however fine and intricate. It is brought chiefly from Botany Bay, whence its name, and from the Mauritius.

69. CAM WOOD is an excellent wood for ornamental turning. It is brought from Southern Africa. Like Botany Bay Wood, it is extremely hard, and of a close, fine texture. Its colour, when cut and exposed to the air, deepens to a rich reddish brown.

Cam Wood.

70. CAMPHOR WOOD. This wood is the product of the Camphor Tree, and is chiefly valuable for preserving furs, etc., from the attacks of moth, when made into boxes. It is used by turners, but is soft in substance and coarse in grain, which makes it difficult to work. It is somewhat yellow in colour and streaked with darker tints.

Camphor Wood.

71. CANARY WOOD. A straight-grained wood of a close texture, and, as the name implies, of a yellow colour. It is imported from South America, and is used by turners and cabinet-makers.

Canary Wood.

72. There are many kinds of wood included under the name of CEDAR, all of which are obtained from cone-bearing trees, or trees of

FIG. 16.—CEDAR TREE.

the Fir kind, and are widely different in qualities and characteristics. The wood of the *Cedar of Lebanon* is reddish, and full of a fragrant resin; it is soft and light, and apt to crack

Cedar: its varieties.

in drying. The wood of the *Deodar*, or *Himalayan Cedar*, is resinous fragrant, compact, and durable, and susceptible of a high polish When polished it has an appearance resembling that of brown agate. The cedar whose wood is most commonly used are species of the Juniper which belong to the Pine tribe. *Red Cedar* and *White Juniper*, indigenous trees of North America, hardly differ except in colour; but the wood of the former is undoubtedly more handsomely marked and diversified, and being scarcer than the latter, commands a higher price. Both woods take a beautiful polish; but they are pitchy, and therefore difficult to cut, requiring at all times careful handling lest they split and break. *Spanish Cedar*, a cedar of the south of Europe, also called *Bermuda Cedar*, is soft, fragrant, and easily worked, though brittle, and is used in making the better class of cedar pencils.

Cedarwood.

73. The wood called CEDARWOOD must not be confounded with the true Cedars described above. It is obtained from a tree growing in the West Indies and Central America, to which the name of *Barbadoes Cedar* is given. The true Cedars belong to the natural order *Coniferæ;* but this is a tree of the natural order *Cedrelaceæ*, which also includes the trees that yield mahogany, satinwood, and the yellow wood of New South Wales. Havannah cigar-boxes are most commonly made of it. It is coarse in grain, very porous, and therefore not suitable for fret-work sawing, though it is useful for lining boxes, and a variety of small cabinet work. Like mahogany, it is not liable to warp. It can readily be stained; but from the coarseness of the grain does not take either oil or polish well. By some writers this wood is called Spanish Cedar, which name, as shown above, truly belongs to the wood of the Bermuda Cedar. In America it is generally so called.

Cherry Wood

74. The heartwood of the CHERRY TREE is hard and fine in texture, and of a pure reddish-brown colour. It is susceptible of a high polish, and is useful for turning and all kinds of fancy work.

Cocabola Wood.

75. COCABOLA is a hard and resinous wood resembling the Brazilian variety of tulip wood. In colour it is reddish, diversified by slight striping. The red sawdust that falls from it when under the saw will stain like dye. When exposed for a long time to the light, the colour is apt to fade. It is liable to warp, but takes a good polish. It is chiefly useful for inlaying.

Cocus Wood.

76. COCUS is a hard wood, yielded by a tree that grows in the West Indies. It turns black when cut and exposed to the action of the air, and for this reason is used by

turners and the manufacturers of musical instruments. It is also called Coca Wood.

77. Coral Wood is a hard and close-grained wood, found in tropical countries, which is yellow when it is first cut, but soon changes to a rich coral red, whence it takes its name. It takes a high polish, and is used in turning and fancy cabinet work. **Coral Wood.**

78. Coromandel Wood, sometimes called Calamander Wood, is brought from Southern India and Ceylon. It is very hard in texture and of a rich hazel-brown colour, streaked with black. It is used by cabinet-makers. **Coromandel Wood.**

79. Dog Wood is the wood of the *Wild Cornel*, a low shrubby tree often found in hedgerows in England. It is used by watchmakers for cleaning out pivot-holes in watches, and by opticians, having the peculiarity of being very free from silex. It is the wood used by butchers for making wooden skewers. **Dogwood.**

80. The wood of the Elder is extremely close in grain and tough, and is used for pegs by shoemakers, and by turners for ordinary kinds of turnery. **Elder.**

81. The wood called Fustic is chiefly used by dyers for dyeing purposes; is suitable for turning and inlaying. It is of a greenish-yellow colour. **Fustic.**

82. Greenheart is a coarse and heavy wood, which is used in shipbuilding, and sometimes by turners, although it does not work well. The tree from which it is obtained is of the genus *Laurus*. It comes from the West Indies and Brazil. In Jamaica it is also called Cogwood. It is of a brownish-green colour when cut, whence its name, but it darkens on exposure to the air, and becomes like lignum vitæ and cocoawood or cocus. **Greenheart.**

83. Gumwood, as the wood of the *Eucalyptus* or blue gum tree of Australia is called, is a hard, heavy wood of bluish colour. It is used in turning and shipbuilding. **Gumwood.**

84. The wood of the Hawthorn or white thorn is of a yellowish-white colour and close, fine grain, for which reason it is much valued for turning. It takes a good polish, and being extremely hard, it is suitable for very delicate work, and tracery. Old wood is sometimes slightly tinged with red and marked with dark veins. **Hawthorn.**

85. Hickory is a tough and elastic wood, much used in the United States for shafts for carriages, spokes of wheels, wooden screws, and all purposes where strength, lightness, and durability is desirable, and indeed requisite, in the timber that is used. **Hickory.**

86. HORNBEAM is an American wood of great strength and toughness, and also of a hard, close grain, and white in colour. Mill-

Hornbeam. wrights find it serviceable for the teeth of cogwheels, etc., and the large pins used in skittle playing are frequently made of it. The English Hornbeam, often planted to form hedges, is a different species. The American variety is sometimes called Ironwood.

87. IRONWOOD is a term applied to various kinds of hard wood

Ironwood. growing in different countries. The Ironwood of South America and the East and West Indies is hard and straight-grained, and frequently used for making ramrods. It is reddish-brown in colour.

88. KINGWOOD is a hard and durable wood, brought from Brazil.

Kingwood. It is used in turning, inlaying, and small cabinet work. It is beautifully streaked in tints of violet, for which reason it is sometimes called *Violet Wood.*

89. LABURNUM is a hard, solid, heavy wood, useful for ornamental

Laburnum. turning and marquetry. The heartwood is of a rich brown colour, diversified by large white medullary rays, which show out conspicuously, like the medullary rays of wainscoat oak, when the wood is cut longitudinally.

90. LANCEWOOD is the wood of a West Indian tree remarkable for

Lancewood. toughness, lightness, and elasticity. Bows, shafts for carriages, billiard-cues, etc., are made of it. It is cut in poles varying from three to six inches in diameter. When steamed, it can be bent into any shape that may be desired.

91. LIGNUM VITÆ is the wood of a tree growing in Central America, from which the medicinal resin called *guaiacum* is obtained. It is a

Lignum Vitæ. kind of Box Tree. The wood is heavy, hard, and close-grained, works easily, and takes a good polish. The central part of the heartwood is brown, next to which are layers of a black tint surrounded by sapwood of a yellowish white. This peculiarity of colouring renders it useful for ornamental turnery. Round rulers are made of it.

92. LOGWOOD is the heavy red heartwood of a South American

Logwood. tree. It is better known for its use in dyeing. It works well, and when polished looks like mahogany darkened by age. It is sometimes called *Campeachy Wood.*

93. NETTLE TREE, or LOTE, is a tree bearing a fruit resembling the

Nettle Tree or Lote. cherry, and growing in Southern Europe. The wood is used by musical instrument-makers. It is close-grained and takes a good polish.

94. OLIVE WOOD is of a close, fine grain, beautifully variegated with curls and knots, and suitable for fret-work, carved work, marquetry, and all kinds of ornamental cabinet-work. It is easily cut, and of an oily nature. Its variegated appearance renders it a desirable wood for veneering.

Olive Wood.

95. PARTRIDGE WOOD is a beautifully variegated wood, much esteemed for ornamental cabinet work, obtained from Brazil. It is heavy, and of a close, fine grain, very hard but easily worked. It is much used for walking-sticks, and for the handles of umbrellas and parasols.

Partridge Wood.

96. The wood of the PEAR, being of a close, fine grain, tolerably soft, and very free from knots, is useful for carving, turning, and a variety of ornamental purposes. It is used for engraving the large letters used by printers in setting up posters, and for making patterns for printing paper for walls and calico. It takes staining readily and is susceptible of a high polish. Pianos, and what is commonly termed ebonised furniture, in black and gold, are made for the most part of the wood of the Pear Tree.

Pear Wood.

97. The wood of the PLUM is dark in colour, and, like pear wood, somewhat soft. The grain is not very close. It is useful in turning, and works easily. It takes a fine polish.

Plum Wood.

98. The wood yielded by the POMEGRANATE TREE is of a brownish-green tint with veins of a darker hue. It is of a close grain, works well, and takes a good polish. It is used chiefly by musical instrument-makers.

Pomegranate Wood.

99. RED SATINWOOD is a hard wood which works well and takes a good polish. It is useful for marquetry, being of a beautiful reddish-purple colour with veins and markings of a darker tint.

Red Satin-wood.

100. ROSETTA WOOD is an East Indian wood of a bright reddish-orange colour, marked with veins and streaks of a darker tint. It is in request for ornamental cabinet work, but is by no means plentiful.

Rosetta Wood.

101. SANDALWOOD is a highly scented wood, something like cedar, obtained from an East Indian tree resembling the privet. The odoriferous properties of the wood, which is of a reddish-yellow colour and works easily, taking a fine polish, renders it useful for making ornamental boxes in which gloves, handkerchiefs, jewellery, and furs are kept.

Sandalwood.

102. SATINWOOD, which takes its name from its soft and lustrous appearance, is of a yellowish tint. It works well and takes a high

polish, and, on account of its colour and natural gloss, forms an appropriate groundwork for marquetry and inlaying, and a useful material for veneering and fret-sawing. It is difficult to attach it to another wood by glueing, owing to the natural oil that it contains. It does not warp or split to any extent, and, by reason of its colour, forms a handsome and agreeable contrast to ebony, tulip wood, rosewood, and other woods of a dark colour. It is brought from the East Indies.

Satinwood.

FIG. 17.—SERVICE TREE.

103. The SERVICE TREE, which is akin to the mountain ash, is, with others of its species, allied to the apple. The wood is hard and of a close grain, and is used to a great extent in making and handling joiners' tools.

Service Tree.

104. TEAK WOOD is the wood of an East Indian tree, extremely hard and durable, and, next to English oak, the best kind of wood for shipbuilding. Ironclad ships are usually built with an inner skin or coating of Teak, and the targets of iron against which heavy pieces of ordnance are fired at Shoeburyness, etc., are generally backed with Teak.

Teak Wood.

105. VIOLET WOOD is the wood of the *Andira violacea*, a tree that grows in Guiana. It is useful for turning. (*See also* KINGWOOD.)

Violet Wood.

106. TULIP WOOD is the wood of a tree that grows in Brazil, resembling rosewood in its resinous qualities, but reddish in colour, striped with darker shades, after the manner of the petals of a tulip flower, whence its name. It is a useful wood for marquetry, but the tints of the wood are apt to fade, losing their natural brightness under exposure to the light.

Tulip Wood.

107. WHITEWOOD, the wood of the North American tulip tree—a tree allied to the magnolia, and bearing flowers resembling the tulip, whence its name—is distinguished by this name, although it is yellow rather than white. Being straight in grain, free from knots, and easily worked, it is used in the United States for ordinary cabinet work and for fret-sawing.

Whitewood.

108. The YEW is an evergreen tree of the genus *Taxus*, allied to the pines. The wood is hard, tough, elastic, and durable. In olden times it was much used in England for making bows. Fine specimens are often to be met with in country churchyards. **Yew, and its uses.**

109. We have now given what may be considered a fuller list of woods used in carpentry than may be absolutely necessary, inasmuch as the amateur artisan may perhaps never handle or even set eyes on a fourth part of them. But though he may never use them, or even see them, it seems desirable that any one who aspires to be a worker in wood should have a general knowledge of the nature, properties, and special uses of the various kinds of woods used in the constructive arts; and with this view, the list that has been placed before the reader has been compiled. Even now it is by no means exhaustive, but it contains a description of every kind of wood that is likely to come under the amateur mechanic's notice. **Knowledge of all woods used in carpentry desirable.**

110. The following is a list of the best timbers for various uses. It is taken from Spon's "Architects', Builders', and Carpenters' Pocket Book"—a most useful work for the practical man, and to which we are indebted for these and many other particulars bearing on the science and theory of carpentry that are given in this chapter. The list will serve as a general summary of what has just been given. **Best timber for various uses.**

(*a*) *For General Construction.*—Oak, Chestnut, Teak, Cedar, Fir, Elm, Walnut, Larch, Pine, Beech, Mahogany, Poplar.

(*b*) *For Scaffolding, Ladders, etc.*—Acacia, Spruce Fir.

(*c*) *Timbers durable in wet places.*—Oak, Alder, Teak, Acacia, Elm, White Cedar, Larch, Iron bark, Beech, Plane, North American Plane.

(*d*) *Timbers durable in dry places.*—Oak, Chestnut, Olive, Mahogany, Larch, Willow, Deal, Cedar, Pine of all kinds, Maple, Ash, Plane, Poplar, Teak, Cedar, Sycamore, Acacia.

(*e*) *For Patterns.*—Deal, Alder, Pine, Mahogany.

(*f*) *Hardest English Woods.*—Box, Oak, Elm, Walnut, Beech.

These woods, with one or two exceptions, have been fully described in the account given above of the various kinds of timber used in building, furniture making, and ornamental carpentry, and constructive arts generally.

111. As the amateur artisan will have obtained a tolerably good idea of the character and qualities of different kinds of timber from what has already been said about them, it is perhaps desirable that he

should now make himself acquainted with the weight per cubic foot in pounds, the average number of cubic feet that go to weigh one ton, and the specific gravity of the best known and most useful varieties of timber. The following table, indeed, will afford the best possible index of comparison of their densities, and a glance at it will, speaking generally, go far to show at once what wood is soft and light, and what is hard and heavy. Wood possessing the characteristics of softness and lightness is usually easily worked and suitable for ordinary purposes, while such sorts as are hard and heavy are closer and finer in the grain, and therefore better adapted for turning and ornamental purposes.

Weight of wood per cubic foot.

112. In the following table the weights per cubic foot in pounds are those given by Tredgold, Rondelet, and others, when the name of the wood is printed in ordinary type, but when the name of any wood is given in italics, the weight per cubic foot has been derived from other sources. The average number of cubic feet of each material that go to make up a ton in weight is calculated from the weight per cubic foot, 2,240 lbs. avoirdupois being one ton, as every reader knows. The specific gravities have been taken, when possible, from recognised authorities, but in some cases they are derived from calculation. Those that have been calculated to complete the table are distinguished thus (*).

Table of weights of wood.

TABLE SHOWING THE AVERAGE WEIGHT PER CUBIC FOOT IN POUNDS, THE AVERAGE NUMBER OF CUBIC FEET PER TON, AND THE SPECIFIC GRAVITY OF THE BEST KNOWN AND MOST USED KINDS OF TIMBER.

Name of Wood.	Specific Gravity.	Weight per cubic foot in lbs.	No. of cubic feet per ton.	Name of Wood.	Specific Gravity.	Weight per cubic foot in lbs.	No. of cubic feet per ton.
Apple ... ... *	·786	49	45·7	Fir Common... ...	·772	31	72·2
Ash	·760	52	43·0	,, Memel	·601	37	60·5
Beech	·696	53	42·2	*Hazel* ... ...*	·641	40	56·0
Birch	·711	42	53·3	*Hornbeam* ... ...*	·770	48	46·6
Box ... ... *	·914	57	39·3	Larch ... ...*	·505	33	67·9
Cedar of Lebanon *	·561	35	64·0	*Lignum Vitæ* ...	1·122	70	32·0
,, *Spanish* ... *	·481	30	74·6	Mahogany Spanish*	10·59	66	33·9
Cherry ... ... *	·673	42	74·6	*Maple* ... ...*	·754	47	47·6
Chestnut ... ... *	·593	37	60·5	Oak, American ...*	·720	45	50·8
Cork ... ... *	·240	15	149·3	,, English ...	·829	53	42·2
Ebony ... ... *	1·010	63	35·5	Pine, Yellow... ...	·508	26	86·1
Elder ... ... *	·673	42	53·3	,, Red	·576	40	56·0
Elm	·579	42	53·3	,, Pitch	·740	45	50·8
Poplar ... ... *	·385	24	93·3	Walnut ... ...*	·659	41	54·6
Sycamore ... ... *	·609	38	58·9	*Willow* ... ...*	·481	30	74·6
Teak	·729	47	47·6	Yew... ... ...*	·802	47	47·6

113. It may be noted here in reference to the above table that in Laxton's "Price Book for Architects, Builders, etc.," it is stated that the following quantities of the materials named, will, upon the average, weigh one ton.

Cubic feet of various woods.

66 feet cubic of deal	29 feet cubic of ebony	34 feet cubic of mahogany
64 ,, ,, fir timber	59 ,, ,, lime	53 ,, ,, walnut
57 ,, ,, elm do.	45 ,, ,, ash	48 ,, ,, maple
51 ,, ,, beech	39 ,, ,, oak	60 ,, ,, pine

114. It will be noticed on comparison of the results exhibited in each table, that while in some cases, and notably that of mahogany, the difference is inappreciable, in others, as in beech, there is a great discrepancy. This is accounted for by the fact that considerable variation is to be found in the specific gravity and weight per cubic foot of different specimens of the same kind of timber. The reader must therefore bear in mind that the statements advanced in the above tables are not established facts which admit of no alteration, but are merely *approximate* values, which are only useful in general calculations, but which cannot be considered as absolutely accurate in individual cases.

Weights given approximately only.

115. Specific gravity may be defined as the ratio of the weight of a body to the weight of an equal volume or bulk of some other body taken as the standard or unit. The standard is usually distilled water for solids and liquids, and air for gases. Thus, when the specific gravity of gold is said to be 19·225, it is meant that when equal volumes or bulks of gold and water are taken, the gold is 19·225 times heavier than the water—that is to say, a cubic inch or a cubic foot of gold weighs respectively 19·225 times as much as a cubic inch or a cubic foot of water, or the water contained in a hollow vessel measuring an inch or a foot, as the case may be, in every direction. The specific gravity of gold is therefore intelligibly expressed in figures by 19·225. In other words, the weight of a piece of gold is equal to the weight of water 19·225 times its size or bulk.

Specific gravity.

116. To show how many of the specific gravities given in the above table have been arrived at, it is as well to explain that the weight of a cubic foot of water is 62 lbs. 224 grains, or 62·32 lbs. avoirdupois. When the specific gravity of a body or any material is known, its weight per cubic foot in pounds avoirdupois may be readily determined; and conversely, when its weight per cubic foot in lbs. avoirdupois is known, its specific gravity may be easily deduced. Thus, to express the specific gravity of any solid or liquid: *Divide the weight in pounds avoirdupois of a cubic foot of the body, whatever it may be, by* 62·32, *the weight in pounds avoirdupois of a cubic foot of distilled water, and the quotient obtained will be the specific gravity of the body.*

To determine specific gravity.

117. Conversely, to determine the weight of a cubic foot of any solid or liquid in pounds avoirdupois: *Multi-*

Weight of a cubic foot.

ply the specific gravity of the body by 62.32, *the weight in pounds avoirdupois of a cubic foot of distilled water, and the result obtained will be the weight of a cubic foot of the body in pounds avoirdupois.*

Buoyancy of woods.

118. The buoyancy of woods that will float in water is according to their respective specific gravities. There are a few kinds of wood so dense and heavy that they will not float in water, or will sink so low in it as to be nearly submerged. Ebony and Spanish mahogany are very dense, heavy woods, and as they are heavier than water, bulk for bulk, they will not float in it. Oak, beech, and ash will sink deep in water, while fir, larch, and cedar displace but a small quantity, and therefore do not penetrate far below the surface. The lightest material obtained from the vegetable kingdom is cork, the bark of a species of oak which abounds in Spain. The weight of a cubic foot of cork is 15 pounds, and its specific gravity no more than ·240, or somewhat less than ¼ lb. avoirdupois; or, in other words, equal bulks of cork and water being taken, the cork is somewhat less than one-fourth the weight of the water. This is why cork is so extremely buoyant in the water and is useful as a material for making lifebuoys, belts, etc., and floats for fishermen's nets.

Strength and breaking strain.

119. It will now be necessary to explain what is meant by the strength and breaking strain or breaking weight of timber, and the amount of pressure or strain which can be safely laid upon it according to its form, thickness, position, etc. This belongs to the *theory*, and not to the *practice* of carpentry; and although a thorough knowledge of the principles that are involved, and which are based on and belong to the branch of mathematical science known as mechanics, is most necessary to the civil engineer, the architect, and the builder, it is by no means so important to the amateur carpenter. Whatever, therefore, is said on this point will be said as briefly as possible, so that it may not become wearisome to the reader.

Theory of carpentry.

120. The principles involved in the theory of carpentry are chiefly brought under consideration in the construction of roofs. It is by no means likely that the amateur will ever put up a building requiring a roof of any great size or space, for his efforts in this direction will not probably extend beyond the simple lean-to roof of a shed built up against a wall, or even unattached to any other kind of building, or the span roof of a greenhouse, or any other structure of an ordinary kind. This will be sufficient to explain why the *theory* of carpentry need not be entered into in this work further than may be necessary to elucidate the reason why a particular

mode of procedure should be adopted in carrying out any work in *practice.*

121. First, with regard to the *strength* of wood. It is by the transverse strength that is inherent in it that a simple beam or piece of wood, be it what it may as regards its form, can resist **Strength of wood.** the action of the weight that is brought to bear upon it. Suppose a beam of timber to be broken by extreme pressure exerted on its centre, the ends being sustained by supports of some kind. On examining the broken part of the beam, it is manifest that the fracture is produced by the extension of the lower fibres and the compression of the upper ones; the former being strained till they are dragged apart, and the latter weakened till resistance is no longer possible by being squeezed together till the fibres are crushed. A rough idea of the effect which it has been attempted to describe may be gained from the accompanying diagram, in which the effect of the weight in upturning the fibres, by dragging them asunder below and crushing them together above, is shown in an exaggerated manner. In fig. 18 is shown a beam or piece of wood of uniform thickness, supported at the extremities. In the centre, in a downward direction, shown by the vertical line C D, a weight, W, is attached sufficiently great to overcome the elasticity and cohesive attraction of the fibres of the beam. The effect is shown in fig. 19, in which, by the downward pressure of W, the fibres that were previously united at D, and just above it, have been broken and pulled apart, while those at C have been pressed together to the extent shown by the small triangles C x z, C y z, which in each portion of the beam have been forced back into the particles next to them, until the corners, as shown by the triangles just named, have disappeared. It must be remembered, that in the illustration the effect is exaggerated, as it has been already said; but a careful study of the diagram will have shown the amateur the necessity of combining a little of the *theory* of carpentry with his practice, so that in framing timbers together he may guard even against deflection, to say nothing of fracture, which would altogether spoil the appearance of his work and detract greatly from its stability.

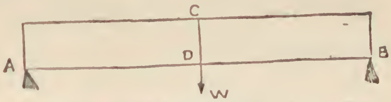


FIG. 18.—BEAM SUPPORTED AT ENDS.

FIG. 19.—EFFECT OF WEIGHT ON BEAM.

122. It has been ascertained by actual experiments that the strength

of a beam or girder of timber, and hence of any piece of timber, whether large or small, increases directly as the width and as the square of the depth. Thus, if a piece of wood measuring three inches in breadth and three inches in depth—that is to say, three inches square in section—will bear a certain weight, a beam six inches broad and three inches deep will bear *twice* the weight; but a beam three inches broad and six inches deep will bear *four* times the weight. The strength is also inversely as the length. That is to say, if two beams of equal breadth and depth be taken, but one of them be twice as long as the other, the longer beam will only bear half the breaking weight that the shorter one will sustain, or, in other words, will be only half as strong.

Strength increased in proportion to width and depth.

123. It will now be clear why, in laying joists to sustain a floor, the timbers are so placed as to have considerable depth from top to bottom, while the breadth is comparatively very narrow.

Why joists are deep.

124. It must be pointed out that the power of resistance in any beam is considerably modified by the manner in which the load is applied to it: thus, if, instead of being collected at the centre, the weight were divided into equal portions and distributed at equal distances along the beam, it would be capable of carrying twice as much. And if the ends of the beam were fixed, as in opposite walls, it would be able in this position to sustain nearly twice as much as it would if the ends had not been fixed. A continued strain tends to weaken the power of resistance in a beam, and the power will be lessened still more when the weight is variable, or a rolling weight instead of a dead weight. The nature of the wood must also be taken into account: thus, some in which the fibre is long and the grain straight will bend to a very great degree, while others in which the grain is short and close, will scarcely bend at all, but break suddenly. In framing timber, then, as the carpenter is called upon to do, all these points must be taken into consideration.

Power of resistance, how modified.

125. The instantaneous breaking weight of any kind of wood is the weight under which it will give way and break when loaded with this weight in the centre. It has been said that the load with which a beam may be weighted with safety, should never exceed more than *one-third* of the breaking weight; but it is better and safer never to let the load exceed *one-fourth* of the breaking weight. Indeed, it is argued that timber is permanently injured if more than this is applied to it. Tredgold, one of the best

Instantaneous breaking weight.

authorities on carpentry, says that a load cannot be looked on as safe if it exceeds *one-fifth* part of the breaking weight.

126. It is by no means a difficult thing to find the breaking weight of every piece of timber, and, this being known, the load that it will sustain without injury, which, as it has just been shown, is estimated by different authorities at from one-fifth to one-third of the breaking weight. The following is a general rule for finding the breaking weight in the middle for girders of wood supported at both ends. RULE.—*Multiply the breadth in inches by the square of the depth in inches, and divide by the length of bearing in feet. The result obtained, when multiplied by a certain constant or invariable quantity, for the kind of timber under consideration, gives the breaking weight in the centre in hundredweights.* This constant or invariable quantity which has been practically determined by a series of experiments, is stated by Barlow to be

Breaking weight: how found.

For English Ash	6	For Dantzic Oak	$4\frac{1}{2}$	For Red Pine	4
,, English Oak	5	,, Pitch Pine	5	,, Riga Fir	3

127. Now, to test this rule, or, in other words, to afford an example of it: To find the breaking weight in the centre of a beam of red pine four inches broad, ten inches and ten feet bearing

Breaking weight in centre of beam.

$$\frac{4 \text{ (The breadth in inches)} \times 10^2 \text{ (square of depth in inches)}}{10 \text{ (Length of bearing in feet)}} = \frac{4 \times 100}{10} = 40.$$

Then 40 (result obtained) × 4 (constant for red pine) = 160 (breaking weight in cwts.)

For a permanently distributed load—that is to say, a load divided into several parts and placed at equal distances along the beam—the breaking weight of such a beam of red pine as we have been considering will be *double* the breaking weight in the middle, or 320 hundredweights. But, according to Tredgold, the safe load should not exceed one-fifth the breaking weight, and as the breaking weight permanently distributed is 320 cwts., the safe load permanently distributed is $320 \div 5$, or 64 cwts.

128. Now from this a formula can be deduced, from which the strength or breaking weight of any of the woods whose constants are given above can be determined when the breadth and depth of the beam in inches, and its length in feet are known. This formula may be expressed as $W = \frac{b \times d^2 \times c}{l}$ in which W represents breaking weight, b breadth in inches, d depth in inches, l the length in feet, and c the constant. For constants for other kinds of timber the reader must refer to theoretical works on carpentry, and

Formula for breaking weight.

the papers of the Royal Engineers, in which full tables of constants are given.

Tables of breaking weight for foot length.

129. In some books, tables are given from which, by an easy operation, the strength of a piece of timber may be ascertained. The following is part of a long and elaborate table given in Laxton's "Price Book": "The weights in this table are, one-eighth of the breaking weight of red pine uniformly loaded, or one-fourth of the same when suspended in the middle. RULE.—To ascertain the strength of a piece of timber, divide the second column by the length of the timber, and the weight in cwts. will be obtained." The first column, it will be noticed, gives the depth and thickness in inches, the second column the safe load or weight of a piece of timber of the depth and thickness specified, one foot in length. Now, as it has been said, the strength of a piece of timber is inversely as its length, or that, when a piece of timber of a certain length, breadth, and depth will break under a certain weight, a piece of the same breadth and depth, but of twice the length, will break in the centre under half that weight, a piece three times as long under one-third the weight, and so on,—it is clear that to obtain the safe load or weight we have only to divide the weight given in the second column by the length of the beam. It will be noticed that the safe load in this table is taken at one-fourth the breaking weight when suspended in the middle, while Tredgold places it at one-fifth. The difference between the two is just one-twentieth; so, in order to reduce any result in the tables to Tredgold's estimate, the reader has only to divide the result by twenty, and subtract the quotient from it, or, in other words, to reduce the result by one-twentieth.

Depth in inches.	Thickness in inches.	1 foot long. cwt.	Depth in inches.	Thickness in inches.	1 foot long. cwt.	Depth in inches.	Thickness in inches.	1 foot long. cwt.	Depth in inches.	Thickness in inches.	1 foot long. cwt.
1½	by 1	2·25	2	by 1½	6·00	3	by 2	18·00	4	by 2	32·00
1½	,, 1¼	2·81	2	,, 1¾	7·00	3	,, 2¼	20·25	4	,, 2¼	36·00
1½	,, 1½	3·37	2	,, 2	8·00	3	,, 2½	22·50	4	,, 2½	40·00
1½	,, 1¾	3·93	2	,, 2¼	9·00	3	,, 2¾	24·75	4	,, 3	48·00
1½	,, 2	4·50	2	,, 2½	10·00	3	,, 3	27·00	4	,, 3½	56·00
1½	,, 3	6·75	2	,, 3	12·00	3	,, 3½	31·50	4	,, 4	64·00
1½	,, 4	9·00	2	,, 4	16·00	3	,, 4	36·00	4	,, 4½	72·00
1½	,, 5	11·25	2	,, 5	20·00	3	,, 5	45·00	4	,, 5	80·00
1½	,, 6	13·50	2	,, 6	24·00	3	,, 6	54·00	4	,, 6	96·00
1½	,, 7	15·75	2	,, 7	28·00	3	,, 7	63·00	4	,, 7	112·00
1½	,, 8	18·00	2	,, 8	32·00	3	,, 8	72·00	4	,, 8	128·00
1½	,, 9	20·25	2	,, 9	36·00	3	,, 9	81·00	4	,, 9	144·00
1½	,, 10	22·50	2	,, 10	40·00	3	,, 10	90·00	4	,, 10	160·00
1½	,, 11	24·75	2	,, 11	44·00	3	,, 11	99·00	4	,, 11	176·00
1½	,, 12	27·00	2	,, 12	48·00	3	,, 12	108·00	4	,, 12	192·00

130. In these tables the strength, or safe load of timber of the length of 1 foot, is given up to a depth of 14 inches, and a thickness of 15

inches, with a result of 2,940 cwts., but from the portion given above it is easy to deduce the quantities in cwts. for other dimensions exceeding those that have been given, remembering always the fundamental rule that if the *breadth* of a beam be *doubled* it will bear *twice* the weight, and that if the *depth* be *doubled* it will bear *four* times the weight; or, to speak more generally, that the increase in strength is directly as the breadth, or as the square of the depth. Now, suppose we had only the second series in this table for pieces of wood of various thicknesses or breadth from $1\frac{1}{2}$ to 12 inches, but of a uniform depth of 2 inches: we know from this that the safe load of a piece 2 in. $\times$ 2in. $\times$ 1 foot is 8 cwt. We wish, however, to know the safe load of a piece 4 in. $\times$ 4in. $\times$ 1 foot. It is clear that as the piece of wood is twice the width and twice the strength—its length will be $8 \times 2 \times 2^2$, or $8 \times 2 \times 4 =$ 64 cwt., as given in the table. Again, if we wish to know the strength of a piece of timber 8 in. $\times$ 8 in. $\times$ 1 foot, it is clearly 64×2 (the breadth being doubled) $\times\ 2^2$ (the depth being doubled and the proportionate increase squared) $= 64 \times 2 \times 4 = 512$ cwt. Again, even at the risk of being tedious, the safe load of a piece of wood (that is to say, red pine, for that is the kind of wood under consideration in all these examples), 3 in. $\times$ 3 in. $\times$ 1 foot is, from the table, 27 cwt., then the safe load of a piece of wood 9 in. $\times$ 9 in. $\times$ 1 foot, will be $27 \times 3 \times 3^2$, or $27 \times 3 \times 9 = 729$ cwts., the increase in breadth or thickness being taken directly, and the increase in depth being squared as before. Indeed, having the rule that has been given, and knowing that the unit of the strength of red pine is that the safe load of a piece of timber 1 in. (depth) $\times$ 1 in. (breadth) $\times$ 1 foot (length) = 1 cwt., we may, by calculation, deduce from this unit of measurement of the strength of red pine, as we may call it, the strength of similar timber of any dimensions. For, suppose, as before, the breadth and depth to be increased to 9 inches, then the safe load $= 1 \times 9$ (direct increase in breadth) $\times\ 9^2$ (the square of the measure in depth) $= 1 \times 9 \times 81 = 729$ cwt., as shown above.

Deduction of breaking weights for other lengths.

131. "In calculating the strength of timber," says Laxton, "only so much of the wood should be measured as is continued through the entire stick. For instance, a tie beam, measuring 8 by 10 inches, having an inch and a half rod passing through it, should be considered as measuring but six and a half inches thick; and if the ends of struts or anything of the kind be cut down into and across the top of the beam two inches, it would then measure but eight inches deep." For example, in fig. 20, let A

Rule in calculating strength of timber.

represent a beam that is eight inches broad and ten inches deep, then if the tie-beam, B, being one and a half inches thick, is passed through a hole of the same diameter, bored to allow its passage, the strength of the beam is weakened to an extent equivalent to the reduction of its thickness one and a half inches throughout its length; and if the strut C were cut into and across the beam to the depth of two inches, the strength of the beam would be weakened to an extent equivalent to the reduction of its depth two inches throughout its length. In short, if a beam of the dimensions given were treated in this way by the insertion of a tie-rod, and strut to the extent described, its actual strength when thus cut and pierced would be no more than that of a beam six and a half inches broad and eight inches deep. The amateur artisan will now see how the strength of timber is weakened by boring holes through it and cutting mortices and notches into it. It is, however, only when the timber thus cut has to sustain any great load or downward pressure, as in the construction of roofs and floors, that this need be taken materially into consideration.

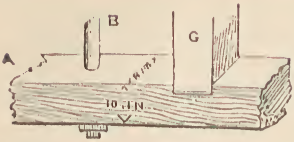


FIG. 20. TIE BEAM WITH ROD & STRUT.

Intimate acquaintance with theory of carpentry not necessary for amateurs.

132. The remarks that have been advanced on the *theory* of carpentry, and the method of calculating the strength of timber will be sufficient, generally speaking, for the purposes of the amateur mechanic, should he be disposed to enter on its study in an elementary manner. It will be necessary to allude to this part of the subject when speaking of the construction of roofs, but it will be endeavoured to touch on it but briefly, and in a manner calculated to redeem it from becoming in any way obtrusive or wearisome.

CHAPTER III.

FELLING AND SEASONING OF TIMBER. DESIGNATIONS AND MARKS OF TIMBER. TIMBER AS SUPPLIED BY TIMBER MERCHANTS. ITS PRICES.

Qualities, etc., of timber—Notes on strength and density of timber—Seasoning of timber—How to guard against shrinkage—Full-grown timber strongest—Season for felling timber—Artificial modes of seasoning timber—Well-seasoned wood more durable—Selection of timber—Wet rot and dry rot—Names of timbers of various sizes—Planks—Deals—Battens—Difference in these timbers—Boards—Feather-edged boards—Scantling—Additional sizes of timber—Quartering—Petersburg Standard, etc.—Facts useful to amateurs—Square of boards or timber—Whence building timber is brought—Selection of timber—Marks on timber—Place from whence timber comes shown by the marks—Properties and value of timber from different places—"Red" and "Yellow" Deal—Prices of timber—Prime cost price of timber per load—To find value of timber per cubic foot from price per load—Prices of wood sold by foot super—Timber merchant's prices—Match-boarding—Prices of Oak, etc.—Prices as charged by builders—Oak in Scantlings, etc.—Timber merchant's prices: why different from builder's prices—Prices as charged by timber merchant—Prices of deals, boards, match-lining, etc.—Venetian laths and trellis-work—Blind-laths, dimensions and prices—Trellis-work, dimensions and prices—Wood-fencing—Egg-boxes for fencing—Prices of posts in Oak, etc., and rails—Arris-rails—Arris-gutters—Park-paling—Oak rails, pales, capping, and gravel-boards—Scaffold poles—Slating laths—Small pales—Authorities for prices—Prices of Scantlings per foot cube—Cost of boards, etc., per foot super.—Foot cube and equivalents—Value of timber per foot cube, how to determine—Knowledge of prices necessary for amateur—Planing-up timber—Help from jobbing carpenter—Scantling, application of term—Cost of Scantlings at 3s. per foot cube—Cost of Scantlings at 3s. 6d. per foot cube—Prices of woods used in ornamental carpentry—Prices of woods for fret-cutting—Prices, why moderate—Plain fret-work, thicknesses suitable for—Hardwood and blackwood—Veneers—Pear-wood, apple-wood, etc.—Timber merchants in various parts—Timber Trades' Journal—Swedish joinery, doors, sashes, etc.—Mouldings: their uses and prices—Directions respecting use of mouldings—Articles in wrought timber—Architraves—Skirtings—Jamb-linings—Door frames—Floor-boards and Match-boards—Sashes and frames—Outside front-doors—Bolection mouldings, meaning of term—Inside-doors—Sash-doors—Fencing and trellis-work.

133. THE present chapter must be regarded as a continuation of or sequel to that which has immediately preceded it. It will be sought in it to make some remarks on the quality of the wood found in different parts of the tree, the felling and seasoning of timber; the names by which different sizes of timber are distinguished, and the distinctive marks of timber from abroad; and the

Qualities, etc., of timber.

different kinds of timber that are procurable from the timber merchant, whether sawn only, or sawn and planed, and their prices. Something also will be said with regard to manufactured articles that can be procured from the timber merchant, such as doors, window sashes and rails, trellis-work, posts and rails, mouldings, etc.

Notes on strength and density of timber.

134. In accordance, then, with the course that has just been marked out, a few notes on the strength and density of timber may not be out of place here. These may be stated as follows :—

(1) The longer the time that a tree is growing, provided always that it has not passed maturity and begun to decay, the heavier and denser its wood becomes.

(2) Generally speaking, the heavier the wood the stronger it is.

(3) The strongest timber is always found in the lower part of a tree.

(4) The straighter the grain of the timber the stronger the wood.

(5) The bark is the weakest part of the tree, the sap-wood within the bark and the heart-wood is not so strong as that which lays between the sap-wood and the heart, or in other words the strongest timber lies between the heart and the sap-wood.

Seasoning of timber.

135. All timber should be well seasoned before it is used by the carpenter, for whatever purpose it may be intended; that is to say, after it has been felled and sawn a sufficient time should be allowed for it to dry, and thus become entirely free from sap and other moisture. To get dry whole timber is a thing impossible, unless you can keep it in store long enough for yourself. To obtain it from a timber-merchant is out of the question, as in the rapid course of business he cannot keep any part of his stock long enough to admit of thorough seasoning.

How to guard against shrinkage.

136. As it is so difficult to get well-seasoned timber, the only thing to be done when designing a building, is to arrange the timber in such a manner that any shrinkage shall in no way affect the stability of the structure. When the term "best timber" is used, as by an architect in his specifications, it is always taken to imply timber that is exceptionally straight in the grain and free from knots and defects. The strongest timber obtainable for building purposes is that which is sawn out of *baulks*, which are the squared trunks of very large trees—we are now speaking of pines and trees of the fir tribe that have reached maturity—and whose wood is consequently the most dense, and has therefore attained the greatest strength. Planks, deals, and battens (terms used in the timber trade to designate pieces of

Full-grown timber strongest.

timber of various widths, and which will be explained presently) are cut out of smaller and younger trees, and will not bear so great a load as full-grown timber.

Season for felling timber.

137. Timber should not be felled until it is of mature age. The best seasons for felling are in the height of summer when the sap is up and ripening in the leaves, or in the depth of winter when the sap has withdrawn to the roots. In either case the trunk of the tree is less full of sap than at other times. When felled and stripped of its bark, the tree should be squared or sawn into logs, and placed in running water, or where it is fully exposed to the influence of sun and air. When removed from the water wood should not be allowed to dry too rapidly. In seasoning, timber will lose from one-fourth to one-half its weight when felled, owing to the evaporation of moisture that it contains. The more porous or less dense the wood, the more sap or moisture it contains, and thus it is that a heavy wood loses less than a light wood in weight when seasoning, or why oak loses less in drying than fir.

Artificial modes of seasoning timber.

138. There are artificial means of seasoning timber, consisting chiefly in exposing it to the action of steam or boiling water, but wood thus heated, although it is not so liable to shrink as timber dried by exposure to the weather, has not the elasticity and toughness of the latter. Sawn timber of whatever size it may be—that is to say, whether in the form of planks, deals, battens, or boards—during the process of seasoning is generally stacked in such a manner as to admit of the free passage of air throughout the pile. In the pile the timber is of course in a horizontal position. The pieces will dry better when placed upright, or when stacked or ranged against a long cross-bar supported on uprights, one at either end.

Well-seasoned wood more durable.

139. The better seasoned the wood, the better and more durable will be the articles that are made from it. It is true that seasoned wood is harder and not so easy to work as unseasoned wood, which contains a considerable amount of moisture while the former is tough and dry. It does not follow that the wetter wood is the easier it is to work, as any one may prove for himself by trying to put the saw through a piece that is thoroughly soaked with water. Good wood, or the "best timber," as already explained, is that which is straightest in the grain and freest from knots. In selecting timber for joinery, care should be taken to avoid any piece that has a knot at the edge, as the knot will be loosened in working and often fall out, causing much disfigurement.

Selection of timber.

140. Timber is liable to destruction from two causes, called respectively *wet rot* and *dry rot*. The former is the result of a chemical decomposition which takes place in timber when it is so enclosed that no air can get to it; the latter is due to the formation and growth of certain fungi. "Experiments," says Laxton, "have proved that impregnating the woody fibres of timber with mineral solutions will impede the decomposition by wet rot, and prevent the growth of those fungi which cause the dry rot, and at the same time render the timber less inflammable. One method of preserving timber, which has been successfully employed, is to dry it and apply a weak solution of corrosive sublimate, or of nitric acid and water, and then paint it with white lead and oil. When the timber has to be fixed near the ground, or in any damp situation, it may be coated with a thin solution of coal tar and fish oil mixed with very finely powdered clinkers from the forge. It is imperative that all timber be properly seasoned before using any preservative application whatever."

Wet rot and dry rot.

141. In the timber trade and in building, the terms *planks, deals, battens, boards, scantling, and quartering*, are used in speaking of pieces of timber of various sizes; it is necessary that the amateur artisan should get a clear idea of what is meant by these expressions, and the term *Petersburg Standard*.

Names of timbers of various sizes.

142. PLANKS are pieces of wood 11 inches in width and 2½ or 3 inches thick, generally sold in lengths of 8, 10, 12, 14, 16, 18, 20, and 21 feet.

Planks.

143. DEALS are pieces of wood 9 inches in width and 2½ or 3 inches thick, generally sold in the same lengths as planks.

Deals.

144. BATTENS are pieces of wood 7 inches in width and 2½ or 3 inches thick, generally sold in the same lengths as planks or deals.

Battens.

145. *The difference then in timbers of these designations lies in their width, a fact that can be easily noted and remembered; the batten is 7 inches wide, the deal 9 inches wide, and the plank 11 inches wide.*

Differences in these timbers.

146. BOARDS are pieces of wood that are of less thickness than planks, deals, or battens. Floor boards are, or ought to be, an inch in thickness. Boards are generally distinguished by their thickness as "half-inch board," "three-quarter board," "seven-eights board," etc. *Feather-edged* boards are boards cut in the manner shown in fig. 21, which is in section, so that

Boards.

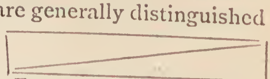


FIG. 21.—FEATHER-EDGED BOARDS.

one side of the plank is thick and the other thin. Boards of this description are used in weather boarding, the thin side being uppermost when the boards are nailed to the framing in a horizontal position. Weather boarding is commenced from the bottom and carried upward, so that the thick edge of each board overlaps the thin edge of the board that is immediately below it.

Feather-edged boards.

147. SCANTLING is defined as a piece of timber cut or sawn to a small size as for rails, etc., but the term is also generally applied to the dimensions of a piece of timber with regard to its breadth and depth. Thus a scantling may be of any dimensions as regards depth and thickness, and not of regulation sizes as planks, deals, and battens.

Scantling.

148. Laxton says : "Although battens, deals, and planks, formerly comprised almost the entire varieties of goods imported into this country, yet of late years immense additions to these sizes have been introduced, until at the present time almost any scantling required is to be found in the docks, including also, occasionally, Dantzic plank and scantling. The advantage thus afforded in the saving upon sawing, cartage, and waste is very considerable."

Additional sizes of timber.

149. QUARTERING is a term applied to pieces of timber almost square in section, cut from deals or planks, which in fact are quartered or divided into four. Thus, without making allowance for the saw cut, a plank of 11 inches wide and 2½ inches thick, can be sawn into quartering measuring 2¾ in. × 2½ in. ; and a deal of 9 inches in width and 2½ inches thick can be sawn into quartering measuring 2¼ in. × 2¼ in. Quartering is the stuff that the amateur artisan will most frequently use in framing sheds and garden structures, as it is strong enough for all general purposes in putting up buildings, etc., of this description.

Quartering.

150. The PETERSBURG STANDARD consists of 120 pieces of timber, 12 feet long, 11 inches wide, and 1½ inches thick, equal in solid contents to 165 cubic feet. The number of running feet of various scantling required to make a Petersburg Standard may be gathered from the annexed table :—

Petersburg Standard, etc.

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
4 × 12	495	2½ × 11	864	2 × 9	1,320	1 × 11	2,160
4 × 9	660	2½ × 9	1,056	2 × 6	1,697	1 × 9	2,640
3 × 11	720	2½ × 7	1,357	1½ × 11	1,440	1 × 7	3,394
3 × 9	880	2½ × 6½	1,462	1½ × 9	1,760	¾ × 9	3,520
3 × 7	1,131½	2 × 11	1,080	1½ × 7	2,262	¾ × 7	4,525

There is another standard in use among timber merchants known

as the London Standard, which consists of 120 pieces of timber 12 feet long, 9 inches wide, and 3 inches thick, equal to 270 cubic feet.

Facts useful to amateurs.

151. The facts stated in the following table may prove useful to the amateur in calculating quantities of timber required for any purpose.

One hundred of deals = 120
One load of timber = 50 cub. ft.
Do. 600 feet of inch boards.
Do. 17 deals 21 ft. × 3 in. × 9 in.
Do. 18 „ 20 „ „
Do. 23 „ 16 „ „
Do. 26 „ 14 „ „
Do. 30 „ 12 „ „
Do. 14 planks 21 ft. × 3 in. × 11
Do. 15 „ 20 „ „
Do. 18 „ 16 „ „
Do. 21 „ 14 „ „
Do. 25 „ 12 „ „

One load of timber is
200 ft. of fir 6 in. × 6 in.
Do. 400 „ „ 12 „ 1½
Do. 300 „ „ 12 „ 2
Do. 250 „ „ 12 „ 2½
Do. 200 „ „ 12 „ 3
Do. 175 „ „ 12 „ 3½
Do. 150 „ „ 12 „ 4
Do. 100 „ „ 12 „ 6
One square is 100 feet super.
One square of rough flooring contains :—
12½ boards of 12 feet.

Or 12½ boards of 12 feet with edges shot.
One square of flooring contains :—
13½ boards of 12 feet wrought and laid folding.
Or 14 boards of 12 feet ploughed and tongued.
Or 16½ battens of 12 feet for wrought folding floors.
Or 7 yellow battens of 12 feet for straight joint floor.

Square of boards or timber.

152. Further, 180 feet run of 7 inch boards or 190 feet run of 6½ inch boards is reckoned a square ; but this is somewhat over the actual quantity. As a square of boards or timber is 100 feet super., to find the number of feet run of boards of any width, all that is necessary is to divide 1,200 by the width of the boarding in inches which will give the result desired : thus, if the boards be 6 inches in width, $1{,}200 \div 6 = 200$ is the number of feet run required to make a square.

Whence building timber is brought.

153. The timber used in building is for the most part pine or fir brought from the northern countries of Europe or North America. The wood best adapted for carpenter's work, that is, for the timbers required in the framework of a building, comes from the Prussian ports of Dantzic and Memel, the port of Riga in Russia, and from Sweden. The best timber for joiners' work for the interior of buildings comes from the Norwegian ports of Christiania and Drammen ; excellent timber for the purposes of the joiner is also sent from Gothenburg, Gefle, Soderham, and other Swedish ports, and from Onega in Russia.

Selection of timber.

154. The following advice is given in Laxton's "Builders' Price Book" for the guidance of purchasers of timber : "In selecting timber the most convenient sizes are 12 inches square. Choose the highest in colour, where the strong red grain appears to rise to the surface ; avoid spongy hearts, porous grain, and dead knots." It has been said that timber cut from baulks is the best and strongest for building purposes, but the quality used should be the "second" or "best middling." The "first" or "crown" quality is selected for its straightness of grain and freedom from knots only. Unfortunately, it is often very sappy and shaky at the heart, on which account a great part of the baulk will often cut up badly.

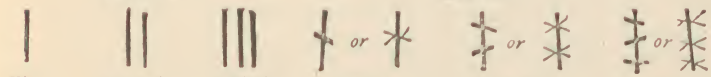
Marks on timber.

155. Timber coming from different ports is distinguished by the special mark or brand that it bears. Generally speaking, timbers from Swedish ports are marked on the ends with *red* letters or brands; those from Norwegian ports being marked with *blue* letters. Canadian timber is marked on the ends with *black* and *white* letters, while the marks which designate its quality are in *red* on the edges of the timber near the ends. Russian timber is *hammer branded* or *dry stamped* on the ends, that is to say, they are marked with letters about an inch long, dented into the timber by means of a punch and hammer. Sometimes timber is scored with large Arabic numerals, but these figures are merely private marks set on the wood by the exporter to note the yard from which it has been sent.

Place whence timber comes shown by the marks.

156. The indications given above, by which the country from which timber has been sent may be recognised, will be sufficent for the general purposes of the amateur artisan; and they are mentioned rather for the purpose of showing what such coloured or indented letters on timber may mean, than with the idea that he may benefit much in any way from the information given. To describe all the marks and letterings by which various qualities of timber from various ports are distinguished would be tedious, and to the amateur practically useless. Timber from Swedish and Norwegian ports is mostly of four qualties, distinguished by different brand marks. Russian timber, and timber from Memel and Dantzic, is also distinguished as "crown," "first quality," "second quality," and "third quality." The following are the "scribe marks" indicating the quality of Memel and Dantzic timber:—

MEMEL. DANTZIC.



First. *Second.* *Third.* *First.* *Second.* *Third.*

The various letterings used would occupy at least two or three pages of this book, even when closely arranged, and to become able to recognise and remember them must be a work of time and patient study.

Properties and value of timber from different places.

157. With regard to the properties and value of timber from different ports, that from Riga, although it is small, being generally under 13 inches square, is the best in quality, and may always be depended on. It is the dearest timber that is sold; but, like many other articles that are comparatively high in price, it is the cheapest in the end. Memel timber is convenient in size, being generally about 13½ or 14 inches square.

Dantzic timber is both tolerably large and very strong, being about 18 or 19 inches square. When the *slab deals* or outsides have been cut away, the log that remains of this timber is generally from 14 to 15 inches square. Swedish timber is very tough and cheap, but, as the trees from which it is cut taper greatly, it is apt to run to waste, on account of its irregularity in size. Red pine is especially noteworthy for strength and durability, and may be used anywhere.

"Red" and "yellow" deal.

158. The red pine deals that the timber merchant speaks of as "red" deals are called "yellow" deals by the builder, and this may occasion some little confusion to the amateur. They are rightly called yellow on account of their general colour, but it is equally correct to call them red, on account of the bright red tint of the graining with which they are marked. Yellow deals are dear, but they are strong and durable. For the carpenter's purposes they are excellent. "For framing," says Laxton, "the best deals to be depended on are the Norway, particularly the Christiania battens, and for panelling the Christiania white. The best for floors are the Drammen and Christiania white; for ground floors, Stockholm and Gefle yellow; for warehouses and staircases, Archangel and Onega planks; and for best floors, Petersburg, Onega, and Christiania battens. Swedish deals are not to be depended on for framing; if framed square at night they will be crooked in the morning." The white fir from Christiania, usually known in the English market as white deal, is useful for furniture, as it unites firmly with glue, takes stain well, and is susceptible of a high polish.

Prices of timber.

159. It is now necessary to pass on to the prices of timber, of which different kinds are sold in different ways. Thus any kind of pine or fir timber may be bought wholesale by the Petersburg standard; but this kind of timber is also sold by the load, as is oak, elm, ash, birch, and teak. Rosewood, again, is sold by the ton, but mahogany, cedar, walnut, maple, and satinwood, by the foot super. Wainscot is sold per 18 feet cube, oak staves, per mille of pipe, and lathwood per cubic fathom. It is impossible to give the prices of all kinds of timber as mentioned and described in Chapter II., and it will therefore be sought to name the prices of those which the amateur is most likely to use or require. For the price of any kind of wood not mentioned application should be made, in the case of any English wood, to a local timber merchant, carpenter, or wheelwright; and for any foreign or rare wood, to London dealers, whose addresses will be found in the *Timber Trades' Journal*, published by MESSRS. J. AND W. RIDER, *Bartholomew Close, London, E.C.*

It must be borne in mind that, like all other things that are bought and sold, the prices of timber are variable and fluctuate considerably at times. The prices given in our lists must therefore be considered approximate only, and as subject to slight increase or decrease, as the case may be, according to the fluctuations of the market. Those who may be led to take an interest in this branch of British commerce will find all the information they can desire or require on the subject in the weekly organ of the timber trades mentioned above.

160. We will begin with the prime cost price of various kinds of timber *per load*, as given in Spon's "Architects', Builders', and Contractors' Pocket Book," which has been already quoted as a valuable authority in these pages. **Prime cost price of timber per load.**

Timbers.	From. £ s. d.	To. £ s. d.	Timbers.	From. £ s. d.	To. £ s. d.
Riga Fir	3 10 0	4 5 0	Dantzic & Stettin Brack and unsquared	5 0 0	6 0 0
Dantzic and Memel Crown	4 0 0	5 10 0	American large yellow Pine	5 0 0	5 10 0
,, Best Middling	3 5 0	4 10 0	,, Waney board	4 0 0	5 0 0
,, Good ditto and 2nd	3 0 0	3 15 0	,, Small	3 15 0	4 0 0
,, Ditto undersized	2 10 0	3 0 0	,, Oak	6 10 0	7 0 0
,, Ditto small, short and irregular	2 6 0	2 10 0	Pitch Pine	3 5 0	3 10 0
Stettin	2 15 0	3 10 0	Rock Elm	4 5 0	5 0 0
Swedish	2 10 0	2 15 0	Ash	4 5 0	5 0 0
,, Small	2 5 0	2 15 0	Quebec large Birch	4 0 0	4 10 0
Swedish and Norway Baulks	1 16 0	2 5 0	New Brunswick and Prince Edward's Isle Birch	3 0 0	3 10 0
Memel Crown Oak	5 10 0	8 0 0	Ditto small averages	2 10 0	2 15 0
,, Brack	5 5 0		Indian Teak	11 0 0	13 0 0
Dantzic and Stettin Crown Oak	5 10 0	8 0 0			

161. When the prime cost of timber per load is known, the rule for general use for finding its value per foot cube is as follows:— **To find value of timber per cubic foot from price per load.**

RULE.—*Add to the price at the yard £1 per load for sawing and carting, and multiply 6½ by the number of pounds. This will give the per foot cube, including 20 per cent. for profit and waste.*

Thus, if the prime cost of American large yellow pine at the yard be £5 per load, add £1 for sawing and carting, which makes £6. Then multiply 6½d. by 6 which gives 3s. 3d. as the value per foot cube, allowing for profit and waste. If the prime cost have any odd shillings take the proportion of 6½d. for the same, thus if the cost of the pine be £5 10s., as 10s. is the half of £1 add one half of 6½d., *i.e.*, 3¼d., to the result already obtained, which makes the cost per foot cube 3s. 6¼d.

162. Let us now consider the prices of mahogany and other kinds of wood sold *per foot super.*, mentioning by the way that the cost of Bahia rosewood per ton is from £12 to £20, and of Rio rosewood from £14 to £25 per ton. Wainscot per 18 feet **Prices of wood sold by foot super.**

cube—Riga crown, English, and Dutch—costs from £5 15s. to £6 10s., and Memel crown from £4 15s. to £5 10s. Any laths that the amateur artisan may require he will buy from the timber merchant ready rent in bundles, so it is unnecessary to say anything about the wholesale price of lath wood; and as it is equally unlikely that he will take to making casks and tubs, the price of oak staves may also be left unnoticed.

Timber.	From.			To.			Timber.	From.			To.		
	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
Mahogany per foot super.							Australian	0	0	3¼	0	0	4
Honduras, cargo average	0	0	4¾	0	0	6½	Pencil	0	0	2	0	0	4½
Mexican ,, ...	0	0	4¼	0	0	5½	*Walnut per foot super.*						
Tobasco ,, ...	0	0	5	0	0	6	Italian...	0	0	4¾	0	0	5½
Cuba ,, ...	0	0	6	0	0	9	Black Sea	0	0	5	0	0	7
St. Domingo ,, ...	0	0	6	0	0	9	Canadian	0	0	3	0	0	4
Do. Curls	0	0	10	0	1	6	*Maple per foot super.*						
Cedar per foot super.							Bird's Eye	0	0	4	0	0	7
Cuba	0	0	5½	0	0	6	*Satinwood per foot super.*						
Honduras and Mexican ...	0	0	5½	0	0	6	Bahama	0	0	7	0	1	0

163. It may be desirable for the amateur artisan to know the wholesale prices of timber, but it is absolutely necessary for him to become acquainted with the timber merchant's prices for comparatively small quantities—which he will purchase at per foot run—of the best dry yellow and white goods for joinery and good general work. It is also requisite to know the prices per 120 of battens, deals, and planks for carcassing and rough purposes, of dry pine, spruce, oak in scantlings and in thicknesses, floor- and match-boarding, and a few miscellaneous articles often required, such as poles, laths of different kinds, palings, trellis work, etc.

Timber merchant's prices.

164. Prices of Best Dry Yellow and White Timber, at per Foot run, for Good Work.

Size and Description.	Good Quality.			Common Quality.	
	d.	d.	d.	d.	d.
3 × 11 Yellow Plank, per foot super.	7	7½	8	4 to	6
3 × 9 ,, Deals ,, ...	5	5¼	5½	3 ,,	4½
2½ × 7 ,, Battens ,, ...	3	3¼	4	2 ,,	2½
3 × 11 White Plank ,, ...	6	6¼	7	4 ,,	5½
3 × 9 ,, Deals ,, ...	6½	4¾	5	3 ,,	4
2½ × 7 ,, Battens ,, ...	2¾	3	3¼	2 ,,	2½

By multiplying any of the above prices by 12 the prices of planks, deals, and battens per piece of 12 feet in length can be immediately ascertained.

165. PRICES OF BATTENS, PLANKS, AND DEALS FOR ORDINARY PURPOSES PER 120.

Size and Description.	£ s.	£ s.	Size and Description.	£ s.	£ s.
2 × 7 Yellow Battens per 120 as 12 feet	10 10	13 10	2 × 10 Yellow Plank per 120 as 12 feet	16 10	20 10
2½ × 6½ ,, ,, ,, ...	9 10	12 0	4 × 9 Yellow Deals as 3 in....	21 0	24 0
2½ × 7 ,, ,, ,, ...	12 10	14 10	3 × 9 ,, ,, ,, ...	18 0	22 10
2½ × 6½ White Battens ...	9 0	12 0	2 × 9 ,, ,, ,, ...	14 10	18 0
2½ × 7 ,, ,, ,, ...	12 10	15 0	3 × 8 ,, ,, ,, ..	18 0	21 0
2 × 7 ,, ,, ,, ...	10 10	14 0	2 × 8 ,, ,, ,, ...	13 10	16 10
3 × 11 Yellow Plank ,, ...	24 0	30 0	3 × 8 White Deals ,, ...	18 0	21 0
2 × 11 ,, ,, ,, ...	19 10	22 10	2 × 9 ,, ,, ,, ...	13 10	15 10

166. PRICES OF DRY PINE AND SPRUCE IN LENGTHS OF 12 FEET.

Dry Pine.	s. d.	s. d.	Spruce.	1st. s. d.	2nd. s. d.	3rd. s. d.
Best Plank 3 by 11 × 12 feet	10 6	11 0	Spruce Planks 3 × 11 × 12 feet	6 6	5 6	4 6
Best Seconds ,, ...	—	7 6	,, Deals	4 6	3 9	3 3
Seconds ,, ...	—	6 6	,, Battens	3 6	3 3	3 0
Good Thirds ,, ...	—	5 6				
Thirds ,, ...	—	4 6				

167. PRICES OF FLOORING BOARDS AND YELLOW MATCH-BOARDING PER SQUARE.

It will, perhaps, be almost unnecessary to remind our readers that the square is reckoned at 10 feet each way, or as comprising 100 feet super. The prices are calculated as including the builder's profit; they are not the timber merchant's prices.

Description.	Price. s. d.	s. d.	s. d.	s. d.	Description.	Price. s. d.	s. d.	s. d.	s. d.
1¼ in. Yellow Flooring ...	16 6	18 6	21 0	22 6	1¼ in. White Matching ...	17 6	18 6	20 0	—
1 ,, ,, ,, ...	14 0	15 6	17 6	18 6	1 ,, ,, ,, ...	14 0	15 6	16 6	17 6
⅞ ,, ,, ,, ...	13 6	14 6	15 6	16 6	⅞ ,, ,, ,, ...	13 6	14 6	15 6	—
¾ ,, ,, ,, ...	12 6	13 6	14 6	—	¾ ,, ,, ,, ...	12 6	13 6	14 6	—
⅞ ,, Yellow Matching ...	15 6	17 6	18 6	—	⅞ ,, ,, ,, ...	15 6	17 6	18 6	—
¾ ,, ,, ,, ...	13 6	15 0	16 6	—	¾ ,, ,, ,, ...	13 6	14 6	15 6	—
⅝ ,, ,, ,, ...	12 6	13 6	14 6	15 6	⅝ ,, ,, ,, ...	12 6	13 6	14 6	—
½ ,, ,, ,, ...	10 6	11 6	12 6	—	½ ,, ,, ,, ...	10 6	11 6	12 6	—

168. Match-boarding is much used for lining walls, etc., and in London warehouses and buildings for trade purposes takes the place of plastering. One edge of the board as at A is tongued or rebated on both sides so as to leave a narrow slip as shown in the annexed diagram. The other edge of the board is ploughed, the groove B being of the exact depth and thickness of the tongue. Where a number of boards are placed edge to edge the tongue of one fits into the groove of the board next to it, and so on. A bead, as at C, is run along the edge just above the tongue so as to break the joint;

Match-boarding.

FIG. 22. MATCH-BOARDING.

or, in other words, to render the line of demarcation between board and board less conspicuous. The amateur artisan will find match-boarding of the greatest use to him for lining any workshop or shed that he may have put up.

169. PRICES OF OAK, WAINSCOT, AND HONDURAS MAHOGANY AT PER FOOT SUPER., IN DIFFERENT THICKNESSES.

Description.	½in.	¾in.	1in.	1¼in	1½in	2in.	2¼in
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Oak—							
Rough	—	—	0 10	—	1 2½	1 6	1 10
Edges shot	—	—	0 11	—	1 3½	1 7	1 11
Framed...	—	—	1 3	—	1 8½	2 2	2 10
Wrought on one side (*add.*)	—	—	0 2	—	—	—	—
Ploughed and tongued „	—	—	0 1½	—	—	—	—
Wainscot and Honduras Mahogany—							
Rough (including waste)...	0 10	1 0	1 1½	1 7	1 11	2 7	—
Wrought on one side (*add.*)	0 2¼	0 2¼	0 2¾	0 2¼	0 2¾	0 3½	—
„ „ both sides „	0 4¼	0 4¼	0 5½	0 5½	0 5½	0 5½	—
Ploughed and tongued „	—	0 1	0 1	0 1	0 1	0 1¼	—
Framed	—	0 5	0 5	0 5½	0 6	0 7	—

170. The prices given in the above table are, it must be remembered, prices at which such materials are supplied by the builder, and the rates at which the labour expended on them is charged. They must not be regarded as the absolute and fixed prices charged by all builders, but as general average prices for materials, or materials and labour combined, supplied by builders. The table itself may require a little explanation. Suppose the amateur wants some oak boarding one inch thick. For this he will have to pay 10d. per foot in the rough, but if he wishes to have the edges shot or planed down before the wood is sent home, he will have to pay 11d. per foot super.; and if he desires to have the board wrought or planed on one side, 2d. per foot super. must be added, and the board will stand him in 1s. 1d. per foot super., or in 1s. 2½d. per foot super., if in addition to this he requires the wood to be ploughed and tongued.

Prices as charged by builders.

171. In addition to the above prices it may be stated that oak may be procured sawn in *scantlings* at about 6s. per cubic foot, and in *plates*, *sleepers*, and *bonds* for about 6s. 9d. per cubic foot; but this, as will be seen presently, is a high average. Fir may be had sawn in *scantlings* at about 2s. 10d. per foot cube, and at 3s. 3d. for *plates*, *lintels*, *bonds*, etc. Planing on sawn fir is generally charged from ¾d. to 1d. per foot super.

Oak in scantlings, etc.

172. As it will be useful for the amateur to contrast these prices as above given with the prices at which goods of a similar kind are supplied from the timber merchant's yard, we will proceed to give the

Timber merchant's prices, why different to builder's prices.

actual prices as taken from a timber merchant's price list. All work, however, it must be remembered, must bear its profit, and it is utterly unreasonable to suppose that materials of a similar kind and quality can be obtained from the builder at the same price at which it can be procured from the timber merchant. And the reason for the difference is mainly this. All the work done in the timber merchant's yard, whether sawing, planing, grooving, tonguing, moulding, or any other kind of work, being done on a large scale is effected by means of machinery, while the work done in the builder's yard is mostly wrought by hand. Work done by machinery can be produced much cheaper than work done by hand ; and even if the builder buys machine-wrought flooring and mouldings and sawn timber to sell again without doing anything to it, he must of necessity sell at an advanced price to get remuneration for, or interest on, his original outlay—just as the retail grocer sells tea, sugar, etc., for more than he pays the wholesale dealer for them to gain compensation for his trouble in acting as middle man between the producer and importer or wholesale merchant, on the one hand, and the consumer, on the other. This has been said in order to show that no one who buys of the builder ought to grumble because the builder charges more for timber, etc., than the timber merchant.

Prices as charged by timber merchants.

173. The amateur artisan may obtain the times' price of any special wood he may require by making application to MR. R. T. PERRY, *Timber Merchant*, 8, *Penton Street*, *Pentonville*, *London*, *N.*, whose stock includes a great variety of foreign and English hard woods, in addition to the fir timber of all kinds usually found in the timber merchant's yard. The following items are taken from his ordinary price list :

Dry pine plank, from 3s. 6d. per plank, measuring 12 ft. × 3 in. × 11 in.
Dry pine plank, 12, 14, and 16 cuts, 5s. 6d., cutting included.
Yellow deals, 4d. per ft.
White deals, 3d. per ft.
Spruce deals, 2s. 9d. per deal, measuring 12 ft. × 3 in. × 9 in.
Battens, 1¾d. per ft.
Pitch pine, 5d. per ft.
Flooring boards, 10s. per square ; that is, per 100 square ft. super.
Match linings, 8s. per 100 ft. super.
Venetian blind laths, 7s. per 100 ft. super.
Best pine squares, 1½ in., 15s. per 120. A large quantity usually in stock and ready for use.
Mahogany, 6d. per ft. in the inch ; that is to say, per 1 in. in thickness.
Birch, 3d. per ft. in the inch.
Beech, 2½d. per ft. in the inch.
Ash, 3d. per ft. in the inch.
Oak stave, 3s. 6d. per length of 6 ft. × 3 in. × 6 in.

Prices of deals, boards, match lining, etc.

174. These prices may be taken as representing fair average charges for such kinds of timber as the amateur will most frequently stand in need of. Mr. Perry also supplies other cheap but serviceable goods, useful for general purposes, and especially for framing and the construction of sheds, outhouses,

etc. The following are the prices at which some of these goods are supplied. The quotations will be useful to amateurs generally, in determining the average outlay absolutely necessary for any kind of work, especially out-door work, that they may be contemplating.

Petersburg yellow deals, 2nd quality, measuring 12 ft. × 3 in. × 9 in., at 3½d. per ft. run or 3s. 6d. per deal.
Yellow boards, 9 in. broad and 1 in. thick, at 1d. per ft. run.
Yellow boards, 6 in. broad and 1¼ in. thick, at 2s. 6d., as 12 ft. × 3 in. × 9 in.; that is to say, at about 7d. per board of 12 ft.

Flooring boards, very good. *Yellow*, ¾ in. thick, 10s. per square; ⅞ in. thick, 11s. 6d. per square; 1 in. thick, 13s. per square *White*, ⅞ in. thick, per square.
Match lining or match boarding, as it is indifferently called, ½ in. thick, 8s. per square; ⅝ in. thick, 10s. 6d. per square; and ¾ in. thick, 12s. per square.

175. Mr. Perry also has specialities in Venetian blind laths and trellis-work, which demand special notice. Venetian blinds are expensive to buy; but if the amateur can get the laths planed ready for use, they are by no means difficult to make. There are few amateurs, again, who do not require trellis-work at some time or other for their gardens, and as considerable time and labour is involved in its preparation, it is an incalculable saving, both in time and trouble, to purchase it ready-made, especially at so low a rate. The trellis-work is sent out *closed* up, in pieces of the dimensions given in the table below. The further it is opened out or extended the more it diminishes in height, like the tobacco tongs of the Marquis of Worcester, described in his "Century of Inventions;" or the child's toy of cross bars pinned together, with the points of the pins projecting upwards, on which figures of soldiers, horses, etc., are placed, and made to alter their relative distances from each other at pleasure by bringing the extremities of the frame work, which are held in the hands, closer together or moving them further apart.

Venetian laths and trellis work.

176. The following is the scale of prices charged for blind laths. Blind laths shorter than the lengths specified can be had any length in inches.

Per 100 ft. super.	s.	d.
Up to 3 ft. 0 in. in length	8	0
,, 4 ft. 6 in. ,, ...	8	6
,, 6 ft. 0 in. ,, ...	9	0
,, 7 ft. 6 in. ,, ...	9	6
Best long lengths	10	0

Per 100 ft. super.	s.	d
Best long lengths, planed and rounded	12	6
Seconds	8	6
Ditto, planed and rounded	11	6
Best selected	11	0
Ditto, hand prepared	14	6

177. The following are the dimensions and prices of prepared trellis work, a good idea of which may be obtained from fig. 23. The laths which are used in this trellis-work are 1 in. wide and ¼ in. thick; it is therefore strong enough for all purposes for which trellis work is ordinarily used, and all that the amateur has to do is to prepare the framing, and fix it in position. It should be said that the laths are all planed,

and will take paint readily. The average price is rather over 7d. per foot super., closed.

No.	Closed.	Open.	Price, per piece.	No.	Closed.	Open.	Price, per piece.	No.	Closed.	Open.	Price, per piece.
	Feet.	Feet.	s. d.		Feet.	Feet.	s. d.		Feet.	Feet.	s. d.
1	$2\frac{1}{2}\times1\frac{1}{2}$	12×1	2 3	6	$2\frac{1}{2}\times4\frac{1}{2}$	$12\times3\frac{1}{2}$	7 0	11	$2\frac{1}{2}\times8$	12×6	12 0
2	,, $\times2$	,, $\times1\frac{1}{2}$	3 0	7	,, $\times5\frac{1}{2}$	,, $\times4$	8 0	12	,, $\times8\frac{1}{2}$	,, $\times6\frac{1}{2}$	13 0
3	,, $\times3$	,, $\times2$	4 4	8	,, $\times6$	,, $\times4\frac{1}{2}$	9 0	13	,, $\times9$	,, $\times7$	14 0
4	,, $\times3\frac{1}{2}$	,, $\times2\frac{1}{2}$	5 2	9	,, $\times6\frac{1}{2}$	,, $\times5$	10 0				
5	,, $\times4$	,, $\times3$	6 0	10	,, $\times7$	,, $\times5\frac{1}{2}$	11 2				

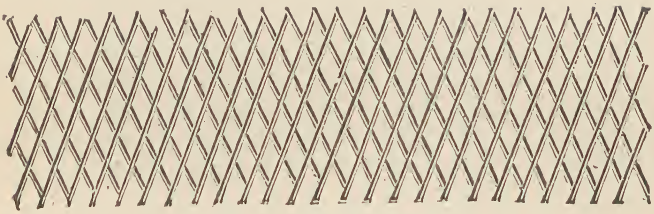


FIG. 23. TRELLIS WORK.

178. It may be that the amateur artisan will require to put up some wood fencing for himself, or desire to have it done for him; in either case it will be desirable to know the cost of materials. Fencing consists of posts and rails only, or of posts and rails with boards or pales nailed vertically to the rails. Posts and rails may be made of ash, oak, or fir; the pales are generally of cleft oak, or pales of fir cut in width of 3in. Sometimes pale boards are used. For rough and ready fencing egg-box boards may be used. These may be obtained at cheap rates from MESSRS. NURDIN AND PEACOCK, *Egg Importers, Oxford Street, London, W.C.,* who will furnish prices on application. The following are the prices of posts, etc., near London; in the country prices rule lower.

Wood-fencing.

Egg-boxes for fencing.

179. The rails, of which the prices are given on next page, are square in section as will be noticed. Arris rails, however, are nearly as strong and as useful, and they possess the advantage of being cheaper. An arris is a section of a V form. Thus a square rail of any dimensions will cut into a pair of arris rails, by sawing it across diagonally, from edge to edge, throughout its length, as shown in section in fig. 24. Again, the gutter sometimes used to catch the drips from a roof, and shown in fig. 25, is

Arris rails.

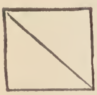


FIG. 24. ARRIS RAIL.

FIG. 25. ARRIS GUTTER.

Arris gutters.

called an arris gutter. It is formed by nailing one narrow slip of board along the edge of a somewhat narrower slip as shown in the illustration. When well tarred inside, this kind of gutter, though not ornamental, may be made useful in emergencies, or to serve as a makeshift in out-of-the-way places for something more costly.

180. PRICES OF POSTS IN OAK, FIR, AND ASH, AND RAILS.

Posts.	Oak.					Fir.			Ash.		
	In. 5×4 s. d.	In. 5×5 s. d.	In. 6×4 s. d.	In. 6×5 s. d.	In. 6×6 s. d.	In. 5×4 s. d.	In. 6×4 s. d.	In. 6×5 s. d.	In. 5×4 s. d.	In. 6×4 s. d.	In. 6×5 s. d.
Length, 5 ft. 6 in. ... *each*	2 3	...	3 8	5 0	...	2 0	2 6	4 0	2 2	3 3	4 7
,, 6 ft. 0 in. ,,	2 5	4 0	3 11	5 7	6 6	2 2	2 9	4 4	2 5	3 7	5 1
,, 6 ft. 6 in. ,,	2 7	...	4 3	6 1	...	2 4	3 0	4 7	2 8	3 11	5 8
,, 7 ft. 0 in. ,,	2 10	4 6	4 6	6 7	7 6	2 7	3 3	4 11	3 0	4 3	6 2
,, 7 ft. 6 in. ,,	3 1	...	4 9	7 1	...	3 0	3 6	5 2	3 4	4 8	6 9
,, 8 ft. 0 in. ,,	3 6	5 8	5 1	7 7	8 6	3 4	3 10	5 6	3 8	5 0	7 5
,, 8 ft. 6 in. ,,	4 3	...	5 6	8 2	...	3 9	4 2	9 9	4 0	5 4	8 2
,, 9 ft. 0 in. ,,	4 11	6 8	6 3	8 10	9 8	4 4	4 6	6 2	4 6	5 5	9 0
,, 9 ft. 6 in. ,,	5 9	...	7 0	9 8	...	5 0	5 3	6 9	5 0	5 10	9 9
,, 10 ft. 0 in. ,,	6 6	...	8 0	11 0	...	5 2	6 0	7 10	5 6	6 6	10 6
Rails.			In. 3×3 s. d.	In. 4×4 s. d.	In. 5×5 s. d.	In. 3×3 s. d.	In. 4×4 s. d.	In. 5×5 s. d.	In. 3×3 s. d.	In. 4×4 s. d.	In. 5×5 s. d.
Length, 8 ft. 0 in. ... *each*			1 9	2 3	2 11	1 6	2 0	2 5	1 7	2 0	2 10
,, 8 ft. 6 in. ,,			2 0	2 6	3 2	1 9	2 3	2 8	1 10	2 3	3 3
,, 9 ft. 0 in. ,,			2 3	2 9	3 6	2 0	2 6	2 11	2 2	2 6	3 6
,, 9 ft. 6 in. ,,			2 8	3 2	4 2	2 4	2 9	3 [illegible]	2 6	2 10	3 11
,, 10 ft. 0 in. ,,			3 0	3 9	4 10	2 8	3 0	3 6	2 10	3 6	4 6

181. As it has been said, pales, cleft pales, or pale boards may be used to complete the fencing. When park paling of cleft pales is made, it is usual to place a board technically called a gravel board at the bottom from post to post. In fig. 26, which shows a piece of park paling, A is the post, B B, B B arris rails, C C the gravel board, D D cleft-pales nailed to the arris rails, and E the capping.

Park paling.

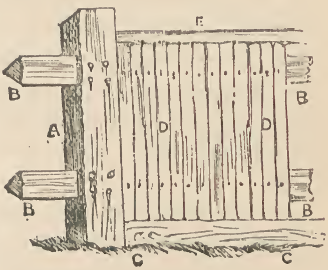


FIG. 26. PARK PALING.

Oak rails, pales, capping, and gravel boards.

Oak arris rails 9 feet long cost 5s. 6d, and 10 feet long, 6s. 6d. *per pair*, or thereabouts. Cleft pales cost, according to length, 6s. 3d. *per score* if 4 feet long; 7s. 3d., 5 feet long; and 9s., 6 feet long. Pale boards are also priced according to length, each being as follows: 3ft. 6in., 5½d.; 4ft. 0in., 6½d.; 4ft. 6in., 8d.; 5ft. 0in., 9d.; 5ft. 6in., 10d.; 6ft. 0in., 1s. Oak capping costs about 2s. 9d. per dozen feet, and gravel boards according to thickness, rough 1½in. board costing, when of Dantzic fir, about 6½d. per foot super., and of oak, 1s. per foot super.

182. Of miscellaneous articles, *poles*, such as are used for scaffolding,

and which the amateur may sometimes require, as, for instance, when he wishes to put up a flag staff, cost from 3d. to 3½d. per foot new, but poles of 22 feet in length may be bought for 3s. each. *Slating laths* cost from 3s. 6d. to 4s. per bundle of each 12 feet long, pantile laths of the same length and the same number in the bundle, at from 2s. to 2s. 6d. per bundle. Trellis laths, 12 in a bundle, and 12 feet long, cost 2s. 6d. per bundle. It is better, however, to buy trellis ready made, it is supplied at the rate of 7d. per super., when closed up in heights varying from 1½ feet to 8 feet, with a width of 2½ feet opening out to 12 feet in width. Pales which are useful for many purposes, especially in making small enclosures and fences, fowl-houses, etc., measuring 3 inches in width and ¾ inch in thickness, are sold for 13s. per hundred, or rather 120, when 4 feet high, and for 14s. per 120 when 4 feet 6 inches high.

Scaffold poles.

Slating laths.

Small pales.

183. It has been said that the preceding prices have been given on the authority of Laxton's "Price Book," and Spon's "Pocket Book of Prices and Memoranda." The following prices of timber in scantlings per foot cube, and for boards and planks per foot super., for wood good enough for the general purposes of joiners' work, are taken from the former. It may happen that some slight discrepancy may be found here and there in prices as stated for the same article, but it must be remembered that all prices are, and can only be, given *approximately*, and that difference in quality will often cause apparent discrepancy in price.

Authorities for prices.

184. PRICES OF TIMBER IN SCANTLINGS PER FOOT CUBE.

	s.	d.		s.	d.		s.	d.
Dantzic, Riga, Memel, or Red Pine, per foot cube … … … …	2	10	Elm or Beech … …	4	0	10×10 … … … …	5	9
Ditto Second quality	2	6	Ash … … … … … …	4	4	12×12 … … … …	6	0
Yellow Pine … … …	2	7	Quebec Oak … … ..	4	0	Old ship oak, upwards from … … … …	4	0
Quebec do. for boards …	3	0	English Oak, not exceeding 6in.×6in. … …	5	0	African Teak … … …	5	0
Swedish, Drammen, and Norwegian … … …	2	6	In Scantlings not exceeding 10 ft.×8in.×8in.	5	3	Indian Teak … … …	7	3
			8×8 … … … …	5	6	Mahogany, upwards from … … … …	10	6

185. COST OF BOARDS AND PLANKS PER FOOT SUPER., INCLUDING SAWING AND DELIVERY.

Thickness.	Elm or Beech.	Oak.	African Mahogany.	Wainscot and Honduras.	Cuba.	Spanish Mahogany.	Thickness.	Elm or Beech.	Oak.	African Mahogany.	Wainscot and Honduras	Cuba.	Spanish Mahogany.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
½ in.	0 2½	…	…	0 7	0 0	1 0	1½ in.	0 7	0 11½	1 2½	1 6	2 3	3 0
¾ ,,	0 3½	…	…	0 10	1 12	1 6	2 ,,	0 8½	1 2	1 6	2 0	3 0	4 0
1 ,,	0 4½	0 8	0 9	1 0	1 6	2 0	2½ ,,	0 0	1 7	1 10	2 9	3 9	5 0
1¼ ,,	0 5½	0 9½	0 11	1 3	1 10½	2 6	3 ,,	1 0	1 10	2 1	3 0	4 6	6 0

186. The foot cubic, being 12 inches every way and containing 1728 cubic inches, is equivalent to a board 12 feet long, 12 inches broad, and 1 inch thick; or to a scantling 12 feet long, 4 inches broad, and 3 inches thick. Mention of this is made to show how easy it is to reduce timber of any dimensions to cubic feet for the purpose of ascertaining its cost at per cubic foot. The rule for ascertaining the value of timber *per foot cubic*, when the prime cost is known, has been already given (See Section 161). The following is a rule, modified from that given by Laxton, for ascertaining the price *per foot super.* for deal, to include 20 per cent. profit, when the prime cost, per 120 delivered, is given.

Foot cube and equivalents.

Value of timber per foot cubic: how to determine.

RULE.—*For the price per foot super.* 1 *inch in thickness, reckon* ½d. *for every* £5 *of the cost of the deals per* 120. *To the result obtained, for any other thickness add or deduct* 1d. *per foot for every* ¼ *inch variation up to and including* 1½ *inches, and above* 1½ *inches* ¾d. *for every* ¼ *inch variation.*

EXAMPLE.—Thus if deals be £35 per 120, deal 1 inch thick will be 3½d. per foot super.; and if £40, 4d. per foot super. And if 1 inch deal be 4d. per foot super., ½ inch will be 2d.; ¾ inch, 3d.; 1¼ inch, 5d.; 1½ inch, 6d.; 1¾ inches, 6¾d.; 2 inch, 7½d.; 2¼ inch, 8¼d.; 2½ inch, 9d.; and 3 inch, 10½d.

187. To the prices already given for timber at prime cost, and from the timber merchant, there is little to be added that can be of actual importance to the amateur artisan. When he knows the approximate prices of timber at per load and in small quantities, the cost of sawing into scantlings, which is done in the timber merchant's yard, the cost of planks, deals, and battens, and various kinds of wrought timber (prepared by machinery for the most part, if not entirely) which is also supplied by the timber merchant, he knows all that is really necessary for any kind of work that he may contemplate. If he have time to plane up his timber for himself, being possessed of sufficient skill and having had sufficient practice to do so, he will not require any assistance in sawing and rough planing beyond that which is done in the timber-yard. Many, however, will want help in planing up wood; and we can say from experience that it is an easy matter, wherever a man may be living, to find a jobbing carpenter who will readily do work of this kind for a comparatively trifling remuneration—who will, in fact, take the wood that has been cut up by the amateur mechanic in the necessary lengths and return it to him nicely planed for further operations. Such a course

Knowledge of prices necessary for amateur.

Planing up timber.

Help from jobbing carpenter.

cannot fail to be serviceable alike to the skilled amateur, who is debarred by lack of time from doing as much in this way as he otherwise might, and to the unskilful beginner who, whether he have time enough for the work or not, is actually unable through want of knowing how, or by not having had sufficient practice, to do that in which he seeks the aid of the jobbing carpenter. The cost of such assistance may be estimated at from ½d. to 1d. per foot super., according to the quantity of work done, but if the amateur pay even twice as much, especially for small jobs, he will find it well worth his while. It does not take very long, it is true, to plane up a piece of wood, but then again it must be remembered that most amateurs have but a limited amount of time to spend in work of this kind, and the preparation of the timber to be used tends to postpone the time of completion—the time which all amateurs so earnestly desire to reach, when engaged on any job, be it what it may—very considerably, and thereby tries the worker's patience. This will be more perceptible in large jobs than in small ones, as a matter of course, as may be readily seen by any amateur artisan who will take the trouble to measure any set of book shelves of ordinary make that he may happen to have in his possession, and reckon up how many feet super. have to be planed up—both in the shelves themselves and in the sides or supports by which the shelves are sustained. Those who have plenty of time at their disposal need not recur to the aid of the jobbing carpenter as often as those who have not, but should endeavour to carry out the work honestly themselves from the commencement to the finish. Indeed all amateurs should be able to plane up a board nicely, although they may not often find time to do their own planing.

Scantling: application of term.

188. It will be remembered that the term *scantling* is applied to timbers of all varieties of dimensions as regards depth and thickness. The tables in pp. 66, 67, will be found useful in facilitating the reckoning of the cost of lengths of different scantlings, according to the price of timber, at 3s. and 3s. 6d. per foot cube. These prices are taken because they approximate closely to the general prices of timbers per foot cube, and they are, moreover, the rates at which these calculations are made in Spon's and Laxton's price books. To find the cost of any scantling of any dimensions given in the tables, first find the price per foot run in either table, and multiply this by the number of feet in the scantling.

For example, it appears from Table II. that the cost of a scantling, 4 inches broad and 4 inches deep, per foot run is 4¾d. If then the length of the scantling be 12 feet, its cost will be 4¾d. × 12 = 4s. 9d.

189. COST OF SCANTLINGS OF VARIOUS DIMENSIONS AT 3s. PER FOOT CUBE. (TABLE I.)

In.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
2	0 1	0 1¼	0 1½	0 1¾	0 2	0 2¼	0 2½	0 2¾	0 3	0 3¼	0 3½	0 3¾	0 4	0 4¼	0 4½	0 4¾	0 5	0 5¼	0 5½	0 5¾	0 6
2½	0 1¼	0 1½	0 2	0 2¼	0 2½	0 2¾	0 3¼	0 3½	0 3¾	0 4¼	0 4½	0 4¾	0 5	0 5¼	0 5¾	0 6	0 6¼	0 6¾	0 7	0 7¼	0 7½
3	0 1½	0 2	0 2¼	0 2¾	0 3	0 3¼	0 3¾	0 4¼	0 4½	0 5	0 5¼	0 5¾	0 6	0 6½	0 6¾	0 7¼	0 7½	0 8	0 8¼	0 8¾	0 9
3½	0 1¾	0 2¼	0 2¾	0 3	0 3½	0 4	0 4½	0 5	0 5¼	0 5¾	0 6¼	0 6¾	0 7	0 7½	0 8	0 8½	0 8¾	0 9¼	0 9¾	0 10	0 10½
4	0 2	0 2½	0 3	0 3½	0 4	0 4½	0 5	0 5½	0 6	0 6½	0 7	0 7½	0 8	0 8½	0 9	0 9½	0 10	0 10½	0 11	0 11½	1 0
4½	0 2¼	0 2¾	0 3¼	0 4	0 4½	0 5¼	0 5¾	0 6¼	0 6¾	0 7¼	0 8	0 8½	0 9	0 9½	0 10¼	0 10¾	0 11¼	1 0	1 0½	1 1	1 1½
5	0 2½	0 3¼	0 3¾	0 4½	0 5	0 5¾	0 6½	0 7	0 7½	0 8¼	0 8¾	0 9½	0 10	0 10¾	0 11¼	1 0	1 0½	1 1¼	1 1¾	1 2½	1 3
5½	0 2¾	0 3½	0 4¼	0 5	0 5½	0 6¼	0 7	0 7½	0 8¼	0 9	0 9¾	0 10½	0 11	0 11½	1 0¼	1 1	1 1¾	1 2½	1 3	1 3¾	1 4½
6	0 3	0 3¾	0 4½	0 5¼	0 6	0 6¾	0 7½	0 8¼	0 9	0 9¾	0 10½	0 11¼	1 0	1 0¾	1 1½	1 2¼	1 3	1 3¾	1 4½	1 5¼	1 6
6½	0 3¼	0 4¼	0 5	0 5¾	0 6½	0 7¼	0 8¼	0 9	0 9¾	0 10½	0 11½	1 0¼	1 1	1 2	1 2¾	1 3½	1 4¼	1 5	1 6	1 6¾	1 7½
7	0 3½	0 4½	0 5¼	0 6¼	0 7	0 8	0 8¾	0 9¾	0 10½	0 11½	1 0½	1 1¼	1 2	1 3	1 3¾	1 4¾	1 5½	1 6½	1 7¼	1 8¼	1 9
7½	0 3¾	0 4¾	0 5¾	0 6¾	0 7½	0 8½	0 9½	0 10½	0 11¼	1 0¼	1 1¼	1 2	1 3	1 4	1 5	1 6	1 6¾	1 7¾	1 8½	1 9½	1 10½
8	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1 10	1 11	2 0
8½	0 4¼	0 5¼	0 6½	0 7½	0 8½	0 9½	0 10¾	0 11½	1 0¾	1 2	1 3	1 4	1 5	1 6¼	1 7¼	1 8¼	1 9¼	1 10½	1 11½	2 0½	2 1½
9	0 4½	0 5¾	0 6¾	0 8	0 9	0 10¼	0 11¼	1 0¼	1 1½	1 2¾	1 3¾	1 5	1 6	1 7¼	1 8¼	1 9¼	1 10½	2 0	2 0¾	2 2	2 3
9½	0 4¾	0 6	0 7¼	0 8½	0 9½	0 10¾	1 0	1 1	1 2¼	1 3½	1 4¾	1 6	1 7	1 8¼	1 9¼	1 10¼	1 11¾	2 1¼	2 2¼	2 3½	2 4½
10	0 5	0 6¼	0 7½	0 8¾	0 10	0 11¼	1 0½	1 1¾	1 3	1 4¼	1 5½	1 6¾	1 8	1 9¼	1 10½	1 11¾	2 1	2 2¼	2 3½	2 4¾	2 6
10½	0 5¼	0 6¾	0 8	0 9¼	0 10½	1 0	1 1¼	1 2½	1 3¾	1 5	1 6½	1 7¾	1 9	1 10½	2 0	2 1¼	2 2¼	2 3½	2 5	2 6½	2 7½
11	0 5½	0 7	0 8¼	0 9¾	0 11	1 0½	1 1¾	1 3	1 4½	1 6	1 7¼	1 8½	1 10	1 11½	2 0¾	2 2¼	2 3½	2 5	2 6¼	2 7¾	2 9
11½	0 5¾	0 7¼	0 8¾	0 10	0 11½	1 1	1 2½	1 3¾	1 5¼	1 6¾	1 8¼	1 9½	1 11	2 0½	2 2	2 3½	2 4¾	2 6½	7¾	2 9½	2 10½
12	0 6	0 7½	0 9	0 10½	1 0	1 1½	1 3	1 4½	1 6	1 7½	1 9	1 10½	2 0	2 1½	2 3	2 4½	2 6	2 7½	2 9	2 10½	3 0

190. COST OF SCANTLINGS OF VARIOUS DIMENSIONS AT 3s. 6d. PER FOOT CUBE. (TABLE II.)

In.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
2	0 1	0 1½	0 1¾	0 2	0 2½	0 2½	0 3	0 3¼	0 3½	0 3¾	0 4	0 4½	0 4¾	0 5	0 5¼	0 5½	0 5¾	0 6	0 6½	0 6¾	0 7
2½	0 1½	0 1¾	0 2¼	0 2½	0 3	0 3¼	0 3¾	0 4	0 4½	0 4¾	0 5	0 5½	0 5¾	0 6¼	0 6½	0 7	0 7¼	0 7¾	0 8	0 8½	0 8¾
3	0 1¾	0 2¼	0 2½	0 3	0 3½	0 4	0 4½	0 4¾	0 5¼	0 5¾	0 6	0 6½	0 7	0 7½	0 8	0 8¼	0 8¾	0 9¼	0 9½	0 10	0 10½
3½	0 2	0 2½	0 3	0 3½	0 4	0 4½	0 5	0 5½	0 6	0 6¾	0 7¼	0 7¾	0 8	0 8¾	0 9¼	0 9¾	0 10¼	0 10¾	0 11¼	0 11¾	1 0¼
4	0 2¼	0 3	0 3½	0 4	0 4¾	0 5¼	0 5¾	0 6½	0 7	0 7½	0 8	0 8¾	0 9¼	0 10	0 10½	0 11	0 11¾	1 0¼	1 0¾	1 1½	1 2
4½	0 2½	0 3¼	0 4	0 4½	0 5¼	0 6	0 6½	0 7¼	0 8	0 8½	0 9¼	0 10	0 10½	0 11	0 11¾	1 0½	1 1	1 1¾	1 2¼	1 3	1 3¾
5	0 3	0 3¾	0 4½	0 5	0 5¾	0 6½	0 7¼	0 8	0 8¾	0 9½	0 10¼	0 11	0 11¾	1 0½	1 1	1 2	1 2½	1 3¼	1 4	1 4¾	1 5½
5½	0 3¼	0 4	0 4¾	0 5½	0 6½	0 7¼	0 8	0 8¾	0 9½	0 10½	0 11¼	1 0	1 0¾	1 1¾	1 2½	1 3¼	1 4	1 5	1 5¾	1 6½	1 7¼
6	0 3½	0 4½	0 5¼	0 6	0 7	0 8	0 8¾	0 9½	0 10½	0 11½	1 0¼	1 1	1 2	1 3	1 3¾	1 4½	1 5½	1 6½	1 7¼	1 8	1 9
6½	0 3¾	0 4¾	0 5¾	0 6¾	0 7½	0 8½	0 9½	0 10½	0 11½	1 0¼	1 1¼	1 2¼	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1 9¾	1 10¾
7	0 4	0 5	0 6	0 7¼	0 8	0 9¼	0 10¼	0 11¼	1 0¼	1 1¼	1 2½	1 3¼	1 4¼	1 5½	1 6½	1 7½	1 8½	1 9½	1 10½	1 11½	2 0½
7½	0 4½	0 5½	0 6½	0 7¾	0 8¾	0 10	0 11	1 0	1 1	1 2¼	1 3¼	1 4½	1 5½	1 6½	1 7¾	1 8¾	1 10	1 11	2 0	2 1	2 2¼
8	0 4¾	0 5¾	0 7	0 8	0 9¼	0 10½	0 11¾	1 0¾	1 2	1 3	1 4¼	1 5½	1 6¾	1 7¾	1 9	1 10	1 11¼	2 0½	2 1¾	2 2¾	2 4
8½	0 5	0 6¼	0 7½	0 8¾	0 10	0 11	1 0½	1 1¾	1 3	1 4	1 5½	1 6½	1 7¾	1 9	1 10¼	1 11½	2 0¾	2 2	2 3¼	2 4½	2 5¾
9	0 5¼	0 6½	0 8	0 9¼	0 10½	0 11¾	1 1	1 2½	1 3¾	1 5	1 6½	1 7¾	1 9	1 10¼	1 11½	2 1	2 2¼	2 3½	2 5	2 6¾	2 7½
9½	0 5½	0 7	0 8¼	0 9¾	0 11	1 0½	1 2	1 3¼	1 4½	1 6	1 7½	1 8¾	1 10	1 11½	2 1	2 2½	2 3¾	2 5	2 6½	2 8	2 9¼
10	0 5¾	0 7¼	0 8¾	0 10¼	0 11¾	1 1	1 2½	1 4	1 5½	1 7	1 8½	1 10	1 11¼	2 0¾	2 2¼	2 3¾	2 5	2 6½	2 8	2 9½	2 11
10½	0 6	0 7¾	0 9¼	0 10¾	1 0¼	1 1¾	1 3¼	1 5	1 6½	1 8	1 9½	1 11	2 0½	2 2	2 3½	2 5	2 6½	2 8	2 9¾	2 11¾	3 0¾
11	0 6½	0 8	0 9½	0 11¼	1 0¾	1 2¼	1 4	1 5¾	1 7¼	1 9	1 10½	2 0	2 1¾	2 3¾	2 5	2 6½	2 8	2 9¾	2 11½	3 1	3 2½
11½	0 6¾	0 8½	0 10	0 11¾	1 1½	1 3	1 4¾	1 6½	1 8	1 9¾	1 11½	2 1	2 2¾	2 4½	2 6¼	2 8	2 9½	2 11¾	3 1	3 2½	3 4¼
12	0 7	0 8¾	0 10½	1 0¼	1 2	1 3¾	1 5½	1 7¼	1 9	1 10¾	2 0½	2 2¼	2 4	2 5¾	2 7½	2 9¼	2 11	3 0¾	3 2½	3 4¼	3 6

Prices of woods used in ornamental Carpentry.

191. Let us now pass on to a review of the prices charged for certain kinds of wood used in ornamental carpentry—that is to say, turning, fret-sawing, and carving, and the thin sheets of wood used in veneering. First, in order, we will take the rare and fancy woods, especially intended for fret cutting, and supplied to the amateur artisan by MESSRS. CHARLES CHURCHILL AND CO., 28, *Wilson-street*, *Finsbury*, *London*, *E.C.*, or by R. MELHUISH, 85 *and* 87, *Fetter Lane*, *Holborn*, *E.C.* These woods, which are the very best of the kind which can be procured, are all planed to the thicknesses designated in the table; and, being well seasoned, are perfectly fit and ready for use.

192. TABLE OF PRICES OF RARE AND FANCY WOODS FOR FRET-CUTTING.

Name of Wood.	Thickness. ⅛ in.	3/16 in.	¼ in.	⅜ in.	½ in.	Name of Wood.	Thickness. ⅛ in.	3/16 in.	¼ in.	⅜ in.	½ in.
	Price per Foot Super.						Prices per Foot Super.				
	s. d.	s. d.	s. d	s. d.	s. d.		s. d.	s. d.	s. d.	s. d.	s. d.
Black Walnut ...	0 5	0 6	0 8	0 9	0 10	White Holly...	0 7	0 8	0 10	1 0	1 2
Plain White Maple	0 5	0 6	0 8	0 9	0 10	Red Cedar	0 8	0 10	1 0	1 2	1 4
White Ash	0 7	0 8	0 9	0 10	1 0	Spanish Cedar	0 8	0 10	1 0	1 2	1 4
Butternut	0 7	0 8	0 9	0 10	1 0	Rosewood	1 4	1 8	2 0	2 6	3 4
Cherry	0 7	0 8	0 10	1 0	1 1	Curled Maple	1 0	1 2	1 4	1 6	1 8
Oak...	0 7	0 8	0 10	1 0	1 1	Bird's Eye Maple ...	1 0	1 3	1 4	1 6	1 8

Prices, why moderate.

193. At first sight the prices of some of the woods as given above may appear high, but it must be remembered that in fret sawing a little wood will go a long way, and that the amateur has the advantage of obtaining his material ready for use, and of a uniform gauge as regards thickness. Some of the woods are by no means easy to work, or smooth with the plane, and this fact alone will go far to convince the amateur that he is really getting his material at a most reasonable rate at the prices charged; especially when it is further taken into account that the wood is, in every case, sound and good and well seasoned.

Plain fret-work, thickness suitable for.

194. The thinner sheets, as they may be called, of the woods mentioned in the above table, are suitable for plain fretwork sawing after the manner of the front of a cottage piano, in which perforated wood work is placed before a piece of coloured silk, fluted or plain, and secured to a suitable framing. By plain fretwork is meant fretwork which is not afterwards touched with the carving tools, and in which the edges of the perforations are

sharp, and at right angles to the surface. The woods of ⅜ inch and ½ inch in thickness, being more substantial, are suitable for wood carving in combination with fretwork sawing.

195. All such articles, as ornamental rails for chairs, and other pieces of furniture, pillars for small tables, legs for tables of all kinds, couches, etc., may be turned in deal, beech, birch, mahogany, or any kind of wood ordinarily used in furniture making; but for turning small articles, such as boxes, chessmen, thimble cases, etc., any hard black wood, such as ebony or Botany Bay wood, also called blackwood and beef-wood (see sec. (8)—or any hard white wood, such as box or holly—may be used, according to the colour required. The wood is comparatively costly; but as the amateur will not want much of it, he will find it better to buy what he wants of some turner, whose address he will find in the London Directory, than to go to the wholesale dealers.

Hardwood and Blackwood

196. The amateur can obtain any veneers that he may require of Mr. John Wright, *Knife Veneer Cutter and Merchant, Arlington Wharf, Arlington Street, New North Road, London, N.*, who will supply any veneer in small quantities to suit the amateur's requirements. The price of veneer will of course vary, as the price of the timber from which it is cut varies; but the following may be taken as approximate rates, *per* 100 *feet super.*: Maple (Bird's eye), thin, 3s., thick, 12s.; Rosewood, thin, 5s., thick, 14s.; Walnut, thin, 5s.; Mahogany, figured or knife cut, 14s., plain, 4s. to 6s.; Birch, figured or knife cut, 12s., plain, 4s.

Pearwood, Applewood, etc.

197. Pearwood, applewood, sycamore, lime, etc., may be obtained, generally speaking, from any timber merchant, but the buyer must be content to pay the timber merchant's own price, as quotations for these timbers are not given in the organs of the timber and building trades. As pearwood and applewood are useful for purposes in which a close grain is required in the timber used, and the heart-wood of the plum is heavy, comparatively speaking, and useful in turning; it is desirable for the amateur to buy a log or two when he may happen to have the opportunity, and stow it away in some corner of his workshop. He will find in this, as well as in regard to many other things, that "store is no sore."

198. As the addresses of various timber merchants resident in the metropolis have been given, it may be useful to our readers, especially such as may live in the north of England and the midland and western counties, to have the addresses of others in these parts of the country, to whom they may apply for

Timber merchants in various parts.

any kind of wood that cannot be obtained of any local timber merchant in their immediate neighbourhood. MR. ROBERT DAWSON, *English Timber Merchant, Stockton-on-Tees*, has always on sale the following timber, either in the tree or plank :—holly, lime-tree, sycamore, hornbeam, pear-tree, apple-tree, chestnut, walnut, yew-tree, thorn, cherry, willow, beech, larch, ash, alder, birch, poplar, and every other description of English timber. MESSRS. JOSEPH SMITH AND SONS, *English and Foreign Timber Merchants, Sheffield*, are buyers of, dealers in, and converters of every description of English and foreign timber; also of fancy woods, as mahogany, rosewood, ebony, cedar, walnut, maple, satinwood, etc. MESSRS. JOHN FORD AND SONS, *Ryeford Saw Mills, Stonehouse, Gloucestershire*, who are buyers and converters of all kinds of English timber, have saw mills in Dorsetshire and Devonshire as well as in Gloucestershire, and would give any information that might be required respecting any kind of timber that would come within their operations.

199. In addition to these addresses others in various localities can be obtained as it has been already stated, from the advertising pages of the *Timber Trades' Journal.* It may be thought that we have exceeded the mark rather than otherwise in pointing out timber merchants from whom the less common kinds of timber may be procured. Those, however, who have found the difficulty of procuring perhaps even a piece of apple or pear wood from local timber merchants, will approve of the special information thus afforded.

Timber Trades' Journal.

200. Of late years the high rate of wages paid to mechanics, and the excessive charges in consequence of this for English-made joinery, have led to the introduction of doors, sashes, and other kinds of joiner's work from Sweden. These articles, which are well worth the attention of the amateur, and which will save him much labour, to say nothing of disappointments arising through failing to turn out the work in sufficiently good style, are supplied by MESSRS. H. ATKINSON AND CO., *Swedish Joinery Warehouses*, 32, *Wharf Road, City Road, London, N.*, who also keep an infinite variety of mouldings, useful for joinery generally speaking, and a number of ornamental purposes which will readily suggest themselves. Messrs. Atkinson and Co. also supply useful ready-made fencing and trellis work, architraves, skirtings, jamb-linings, door frames, single rebated and beaded, and floor and match-boarding of several dimensions.

Swedish joinery, doors, sashes, etc.

201. An immense variety of MOULDINGS of different kinds are used in the building trade, far greater, indeed, than any one might imagine.

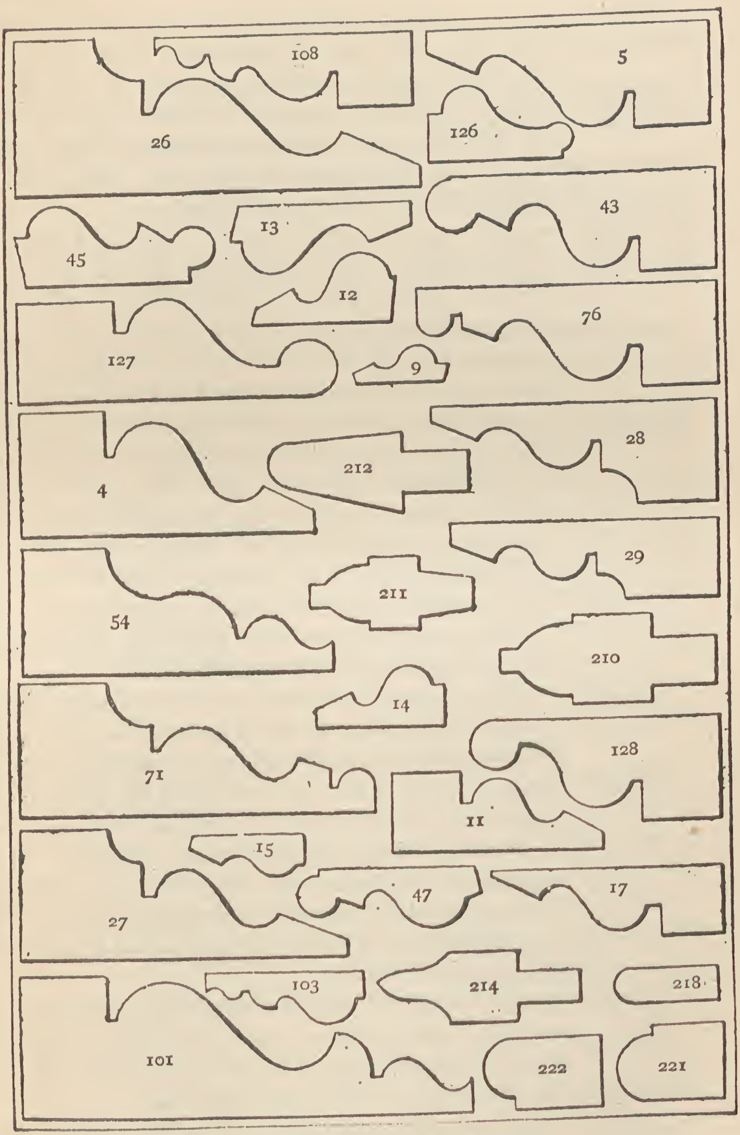


FIG. 27. EXAMPLES OF MOULDINGS.

They are used for all sorts of purposes, as, for example, within the panels of doors, at the top of skirting boards when the boards are not finished with either moulding or beading, round the frames of doors

and windows, as sash bars for the reception of glass, beading, and in window frames to keep the sashes in place when being moved up and down. In the preceding page (fig. 27) patterns in section of mouldings supplied by Messrs. Atkinson and Co. are given, the numbers attached to them being those by which they are distinguished in their list. The prices of those which are figured are as follows, per 100 feet.

Mouldings: their uses and prices.

No.	s.	d.	No.	s.	d.	No.	s.	d.	No.	s.	d.	No.	s.	d.	No.	s.	d.	No.	s.	d.	No.	s.	d.
4	9	0	12	3	4	17	4	9	29	5	4	54	8	7	103	2	11	128	6	7	214	5	8
5	6	10	13	3	7	26	12	7	43	8	7	71	13	5	108	5	4	210	6	7	218	1	9
9	1	9	14	3	11	27	10	5	45	4	1	76	2	11	126	3	10	211	4	1	221	2	4
11	4	1	15	2	5	28	7	2	47	3	10	101	5	4	127	9	1	212	5	8	222	2	9

202. All the large mouldings may be used for nailing to the inner face of window frames, and the outer and inner faces of door frames. Nos. 17, 29, and 108 would be large and bold enough for this purpose for amateurs: the smaller moulds, such as Nos. 14 and 15, are suitable for edging the framing of panels of doors formed by the styles and rails. Nos. 210, 211, 212, and 214, are rebated or rabetted for the reception of glass, and may be used as sash bars or for the bars of window frames. Nos. 221 and 222 are bold beadings, suitable for the capping of match-boarding, carried part way up a wall from the flooring, etc., and No. 218 may be used as a beading or as the slip placed on either side of a window frame, to confine the sashes to their proper place.

Directions respecting use of mouldings.

203. Messrs. Atkinson supply many other articles in wrought timber, that is to say, ready for immediate use, which the amateur will find to be most useful to him, because he is saved the time and labour involved in their preparation if he makes them himself. It will be as well to mention them seriatim, giving as far as possible, in each case, the limits of dimensions from the smallest size sold to the largest, and the prices in accordance therewith. The amateur can then easily arrive approximately at the price of any intermediate size he may require, or he will be supplied with it on application to the makers.

Articles in wrought timber.

204. ARCHITRAVES from 3in. broad and ⅞in. thick to 6½in. broad and 1½in. thick, at from 7s. 8d. to 26s. 1d. The prices here given, except where otherwise stated, or for articles which cannot be sold thus, are stated at per 100ft. run.

Architraves.

205. SKIRTINGS from 4½in. broad and ⅝in. thick to 14in. broad and 1in. thick at from 8s. 11d. to 24s. 6d.

Skirtings.

206. JAMB-LININGS, double and single rebated, beaded and square edges, from 4½in. broad and 1in. thick, to 6¼in. broad and 1¼in. thick, at from 10s. 6d. to 26s.

Jamb-linings.

207. DOOR FRAMES, single rebated and beaded, 5¼in. by 3½in., at 38s. 6d., and 4¼in. by 3in. at 26s. 5d. Door Frames.

208. FLOOR BOARDS and MATCH BOARDS of various dimensions, according to thickness. Prices of these have been mentioned approximately in previous sections. Floor boards and match boards.

209. SASHES AND FRAMES for windows can be had of any size and description made to order at from 8d. to 10d. per foot super. Sashes and Frames.

210. Doors are of various prices according to description and make. OUTSIDE FRONT DOORS—*Six panels*—with bolection moulding one side, 6ft. 10in. high, 2ft. 10in. broad, and 2in. thick, at from 19s. 3d. to 21s. 9d.; and 7ft. high, 3ft. broad, and 2in. thick, at from 20s. 4d. to 22s. 10d. If finished with large bolection, add 1s. to 1s. 6d. to price of doors. *Four panels*, with bolection moulding one side, 6ft. 10in. high, 2ft. 10in. broad, and 2in. thick, at from 17s. 7d. to 20s., and 7ft. high, 3ft. broad, and 2in. thick, at from 18s. 6d. to 20s. 11d. From 9d. to 1s. must be added to the price of the doors for large bolection moulding. Outside front doors.

211. The term *bolection* will perhaps require explanation. In figs. 28 and 29 A represents the frame of a door on one side of a panel, and B the panel. If the moulding does not project beyond the face C C of the frame, as D in fig. 28, it is simply described as a moulding; but if it projects beyond the face of the framing, making a narrow projecting framing between the frame of the door and the curved part of the moulding, it is described as a *bolection* moulding. The origin of the word is uncertain, but it is apparently to be traced to the root from which comes *bole*, the rounded stem of a tree, and the word *belly;* and this is the more likely when it is considered that the moulding thus designated is one that bulges out and projects forward beyond the face of the work. Bolection mouldings, meaning of terms.

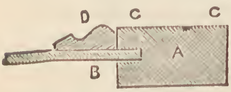


FIG. 28. MOULDING.

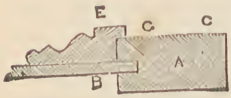


FIG. 29. BOLECTION MOULDING.

212. INSIDE DOORS.—*Four panels, square*, that is to say, when the edge of the framing projects at right angles from the face of the panel, from 6ft. 8in. to 7ft. high, 2ft. 8in. to 3ft. broad, and 2in. thick, at from 11s. 6d. to 12s. 7d.; from 6ft. 6in. to 6ft. 10in. high, 2ft. 6in. to 2ft. 10in. broad, and 1½in. thick, at from 8s. 3d. to 9s. 4d.; and from 6ft. 4in. to 6ft. 7in. high, 2ft. 4in. to 2ft. 7in. broad, and 1¼in. thick, at from 6s. 7d. to 7s. 11d. If moulded on Inside doors.

one side, add from 10d. to 1s. 3d., and if on both sides, from 1s. 8d. to 2s. 6d. to the price of the doors. *Four panels*, *bead and butt*, *and bead and flush*, that is to say, when one side of the panel is flush with the framing, the vertical edges of the panel being broken by a bead, from 6ft. 8in. to 7ft. high, 2ft. 8in. to 3ft. broad, and 2in. thick, at from 17s. to 19s. 6d.; from 6ft. 6in. to 6ft. 8in. high, 2ft. 4in. to 2ft. 8in. broad, and 1½in. thick, from 10s. 5d. to 11s. 10d. If moulded, add from 1s. to 1s. 3d. to the price of the doors.

Sash doors.

213. SASH DOORS, that is to say, doors with glass in the upper part. *Without shutters*, from 6ft. 9in. to 7ft. high, 2ft. 9in. to 3ft. broad, and 2in. thick, at from 14s. 4d. to 16s. 3d.; from 2ft. 6in. to 6ft. 10in. high, 2ft. 6in. to 2ft. 10in. broad, and 1½in. thick, from 11. 6d. to 13s. 9d. *With shutters*, from 6ft. 9in. to 7ft. high, 2ft. 9in. to 3ft. broad, and 2in. thick, at from 19s. 3d. to 20s. 4d.; from 6ft. 8in. to 6ft. 10in. high, 2ft. 8in. to 2ft. 10in. broad, and 1½in. thick, from 17s. 4d. to 18s. 8d.

Fencing and trellis work.

214. FENCING in lengths of 9ft., with *one* foot included if 4ft. in height, 13s. 6d. per length, and if 3ft. 6in. high, 11s. per length. Extra foot, to complete length, according to height of fence. Gates for this kind of fencing can be supplied at moderate rates in accordance with any design that may be furnished. TRELLIS WORK, which, as it has been said, is most useful to the amateur when sold in lengths ready for fixing, can be had in heights varying from 3ft. 6in. to 9ft. at the rate of 7d. per foot super. when closed up.

CHAPTER IV.

THE TOOLS USED IN CARPENTRY AND JOINERY: THEIR CLASSIFICATION ACCORDING TO THEIR USES.

Tools used in Carpentry and Joinery—Wood-working Machinery—Costly and almost useless to Amateur—Cheap Planing-machine desirable—Classification of Tools—Hammers—Joiner's Hammers—Claw Hammer—American Adze-eye Hammer—Prices of Hammers—Uses of Hammers—Mallets—Beetle and Wedges—Adze and its uses—Axe or Hatchet—English Hatchet—American Axe—Tools should be kept under lock and key—Rasping Tools—Saws: their nature and operation—Circular Saws—Cross-cut Saws—Saws required by Amateur—Hand Saw—Combination Saw—Tenon Saw—Dovetail Saw and Sash Saw—Keyhole Saw—Bow or Frame Saw—Rasps for Wood—Files for Metal—Various forms of Files—Paring Tools, or Edge Tools—Planes necessary to Amateur—Jack Plane, its construction and action—Smoothing Plane—Trying Plane—Difficulty to Amateurs in using Plane—Bailey's Patent Adjustable Bench Planes—Stanley's Patent Adjustable Planes—Moulding Planes, etc., not required by Amateur—Rabbet or Rebate Plane—Old Woman's Tooth—Fillisters of various kinds—Spokeshave—Drawing-knife—American Iron Spokeshaves—Chisels and Gouges—Chisels, how distinguished—Firmer Chisels—Mortise Chisels—Turning Chisels—Gouges—Cold Chisels—Prices of Chisels and Gouges—Chisels and Gouges required by Amateur—Boring Tools—Bradawls: their varieties—Gimlets: their varieties—Cost of Bradawls and Gimlets—Augers: their varieties—Prices of Augers—Bits, Braces, and Drills—Patent Breast Drill—Bit-brace, or Stock and Bit—Modern Iron Brace—Barber's Patent Bit Brace—Augular Bit Stock—Bits for Brace—Prices of Bits—Clarke's Patent Expansive Bit—Douglass' Cast Steel Bits—Holding or Grasping Tools—Pincers and Pliers—Flat Pliers—Cutting Nippers—Round-nosed Pliers—Spring Pliers, for Fly making, etc.—Utilisation of Packing Cases, etc.—Causes of damage to Tools—Victor Nail Puller—Wrench, or Spanner—Vices necessary to Amateurs—Ordinary Hand-vice—Bench Vice—Patent Vices—Improved Hand-vice—Tools of Guidance and Direction—The Line and Reel—How to use the Line—Carpenter's Rule—Square and Bevel—Hardened Try Square and Flush T Bevel—Ames' Patent Universal Square—Marking Gauge—Mortise Gauge—Levels: their principle—Spirit Level—Method of applying Level to Long Lengths—Requirements for accurate Levelling—Level positively accurate for own length only—Use of Straight-edge in levelling—Plumb Level—Plumb Bob—Use of Plumb Level in fixing Posts, etc.—The A Level, or Bricklayer's Level—American Spirit Levels—Stanley Levels—Adjustable Plumb and Level—Prices of Common Levels—Mitre Box—Construction, etc., of Mitre Box or Block—Improved American Mitre Box—Compasses and Callipers—Compasses with Arc—Callipers—Calliper Rules and Squares—Stanley's Ivory Calliper Rules—Miscellaneous tools used in Carpentry—The Screwdriver—Round-bladed Screwdrivers—American Cast Steel Screwdriver—Nail Punch, or Brad Punch—Reamer, or Rymer—Cramp, or Clamp—Joiner's Cramp—Hammer's

Adjustable Clamp—Simple Clamp, that can be made by Amateur—Carpenter's Pencil—Pencil often mislaid—Glue-pot—Construction of Glue-pot—Recipe for making Glue—Brush for applying Glue—Oil-can—Forms of Oil-can—"Good-enough" oiler—Sandpaper, or Glasspaper—Tools in combination—Boardman's Combination Wrench—Pads, or Patent Tool-handles with Tools—Handles for various tools—Tack-hammer, Setter, and Puller—Articles for fastening pieces of Wood together—Wooden Pegs and Treenails—Pegging Mortise and Tenon—Wedges in Tenon—Nails: their varieties—Brads—Joiner's Cut Brads—Floor Brads—Cut Nails—Clasp Nails—Rose Nails—Clout Nails—Iron Nails unfit for nailing Zinc—Lath Nails—Iron Tacks and Tench Tacks and Nails—Prices of Nails—Screws: their forms—Principle of the Screw—Prices of Screws—Round-headed Screws—Brass Screws—Holes for reception of Screws—Greasing Screws before driving—Bolts and Nuts—Female Screw—Where to get Good Nails, etc. —Tool-boxes for Amateurs.

Tools used in carpentry and joinery.

215. AFTER considering the various kinds of wood that are commonly used in Carpentry and Joinery, the prices at which these woods are sold by the timber merchant and the builder, and the various articles that may be had partly wrought or entirely finished from the timber merchant, we pass naturally enough to a review of the tools that are used in the various operations that are performed by the carpenter or joiner by hand. There is a large variety of wood-working machines used in the preparation of wood for the carpenter's or joiner's purpose; but little need be said about these, as, with very few exceptions, they are beyond the province of the amateur. Machinery facilitates production in large quantities, and this the amateur artisan does not need or expect to do. At the utmost he will do but little, comparatively speaking, and that little he should do well and in a workman-like manner.

Wood-working machinery.

216. Wood-working machinery comprises circular and band saws of considerable size, driven by great power, for cutting baulks of timber into planks, deals, battens, and scantlings of various dimensions, and for cutting planks, etc., into boards and quartering. There are also planing-machines, for taking off the rough surface from sawn wood; machines for making mouldings; dove-tailing machines; tenoning and trenching machines; mortising machines, and others for boring and making slots in timber. These are all costly, and, with few exceptions, would be actually useless to the amateur artisan. What is very much required is a compact and tolerably cheap planing-machine, available for such purposes as come within the ordinary work of an amateur; the cheaper, as far as is compatible with goodness, the better. It is also desirable that he should have such an arrangement of his ordinary bench as may be calculated to render it available for the use of cir-

Costly and almost useless to amateurs.

Cheap planing-machine desirable.

cular saws with teeth of various sizes, from one sufficiently coarse to cut a three-inch plank into quartering or laths, to a fine plate furnished with teeth small enough to cut tenons and dove-tailing. With such helps to sawing and planing in connection with his carpenter's bench, the amateur would find much work that he now does with difficulty comparatively easy. Of the circular saw adaptation mention will be further made when speaking of the bench. The amateur's cheap planing-machine has yet to be made. Descriptions of such have been given occasionally, and hints for the construction of these machines; but the instructions have proved either unintelligible or impracticable.

217. The able author of "The Amateur Carpenter," the late Mr. Ellis A. Davidson, who during his life rendered by his technical works considerable and valuable aid to the amateur and the regular artisan, describes the tools used in carpentry in groups as follows, namely, "Striking tools, saws, cutting tools, planes, boring tools, pincers, guides, and auxiliary appliances." It seems possible however to render the classification even more complete by the following arrangement:—

Classification of tools.

I. STRIKING TOOLS.
   1. *Tools that are used for striking only, as Hammers and Mallets.*
   2. *Tools that are used for striking and cutting, as Hatchets, Axes, Adzes, etc.*

II. RASPING TOOLS, OR TOOLS THAT ACT BY ABRASION.
   1. *Saws of all kinds, for cutting wood asunder.*
   2. *Rasps and Files, for smoothing, shaping, cutting, etc., etc.*

III. PARING TOOLS OF ALL KINDS.
   1. *Planes of various kinds, for smoothing, moulding, etc.*
   2. *Spokeshaves and Drawing-knives.*
   3. *Chisels and Gouges.*

IV. BORING TOOLS.
   1. *Bradawls, Gimlets, and Augers.*
   2. *The Braces and Bit, sometimes called Stock and Bit.*

V. HOLDING OR GRASPING TOOLS.
   1. *Pincers and Pliers, Nippers, Spanners, and Wrenches.*
   2. *The Vice, including Hand-vice, Bench Vice, etc.*

VI. TOOLS OF GUIDANCE AND DIRECTION.
   1. *The Carpenter's Rule and Chalk Line.*
   2. *The Square, Bevel, Gauge, Mortising Gauge, Mitre Box.*

3. *Spirit Level, Straight Edge, Plumb and Level.*
4. *Compasses and Callipers.*

VII. MISCELLANEOUS TOOLS NOT SUBJECT TO CLASSIFICATION.

1. *Screwdriver, Nail-punch, Scriber, Rymer or Reamer, etc.*

VIII. TOOLS IN COMBINATION AND USEFUL AIDS TO HOUSEHOLD CARPENTRY.

Hammers.

218. Taking the tools necessary to the amateur artisan in the order above given, we will commence with *Hammers.* Of these the amateur should possess three—namely, an ordinary joiner's hammer for heavy work, a lighter one of the same form for medium work, and a light hammer with a small face, usually known as a "ladies' hammer," for driving brads and small fine nails into small light work. If he determines to do any veneering there is a special kind of hammer used for this purpose which must be obtained.

Joiner's hammer.

219. In the accompanying illustration fig. 30 shows the form of the head of the ordinary joiner's hammer. For such work as the amateur artisan will do one of these weighing from 1lb. to 1¼lbs. and another from ½lb. to ¾lb. will be sufficient. The weight, however, that may be preferable can best be determined by the amateur himself when making his selection. The handle of the joiner's hammer passes through the head, and is secured in its position by a wedge driven into a saw-cut made in the end of the handle. The light hammer necessary for fine work is shown in fig. 31. The face (A in fig. 30) of the joiner's hammer should be from ⅞in. to 1in. for the larger hammer, and from ⅝in. to ¾in. for the smaller one. The handle, which should be of ash, swells towards the lower end to afford a firm grasp for the hand. The face (B in fig. 31) of the ladies' hammer for light work is from ⅜in. to ½in. in diameter. The opposite end is slightly curved and forked so as to form a claw for raising nails. It is fastened to the handle by shanks which proceed from either side of the head. The veneering hammer, which is useless for any other purpose but that of veneering, will be described when this branch of ornamental joinery comes under consideration.

FIG. 30. JOINER'S HAMMER.

FIG. 31. LADIES' HAMMER.

Claw hammer.

220. Many other kinds of hammers are used for various kinds of work, but those described above will be sufficient for the amateur's purpose. The ordinary English claw hammer or Kent claw hammer, as it is sometimes called, is more useful for gardening purposes than for carpentering. The presence of the claw

renders the amateur inclined to turn the hammer into a wrench and lever for withdrawing nails from wood, etc., and it sometimes happens that this weakens the hold of the handle in the hammer-head and spoils the hammer. The best form of claw hammer is the American adze-eye hammer, sold by Messrs. Churchill and Co., as shown just below in fig. 32.

American adze-eye hammer.

FIG. 32. AMERICAN ADZE-EYE HAMMER.

221. The prices of ordinary joiner's hammers range from 1s. to 3s., according to size and weight: light hammers for fine work from 1s. to 2s., and claw hammers from 8d. to 1s. 9d. The American adze-eye hammers range in price, according to weight, from 1s. 4d. to 2s. 4d. each. The manner in which the handle is set in the head renders them stronger and far better adapted for lifting nails than the ordinary claw hammer, whose head is usually fastened to the handle by shanks.

Prices of hammers.

222. It may seem somewhat superfluous to remark that hammers are meant for driving nails, striking punches, etc., and not for hitting wood; but it unfortunately happens that the amateur, and the artisan too sometimes, is given to use the hammer for striking the handle of his chisel when mortising, or the screwdriver in getting out obstinate nails, much to the detriment of the handle, which is bruised and split by the blows of the hammer and thereby rendered unfit to be held in the hand for cutting, in the case of the chisel, or for inserting or withdrawing screws in the case of the screwdriver. Wood must in all cases be struck by wood, when it is to be struck at all; and when it is necessary to strike the handle of a chisel in mortising, or the handle of a screwdriver, it should be done with the tool proper for the purpose, which is the wooden *Mallet*.

Uses of hammers.

223. The most convenient form for the mallet is that which is shown in fig. 33, an illustration of the square American mallet sold by Messrs. Churchill and Co. A convenient size, the head being 6in. long and the face 2½in. × by 3½in., is sold in hickory

Mallets.

mortised for 9d., and in lignum vitæ for 1s. 6d. Round mallets 5in. long and 3in. in diameter may be had in hickory for 7d., and in lignum vitæ for 1s. 1¼d. each, the handles being mortised into the heads. The ordinary beech mallet used by English joiners has a square head, but the edges are not bevelled as in the illustration, and the handle is square, with the edges taken off all round in the middle to allow it to be conveniently grasped by the hand. The handle is consequently somewhat larger where the third and little finger closes over it, and less liable to slip from the grasp. A convenient size of this mallet is 4½in. long with a face 2¾in. × 3¾in., costing 1s. Prices of English beech mallets vary, according to size, from 6d. to 1s. 9d. The amateur must remember that tools of a medium size are always likely to be most useful to him.

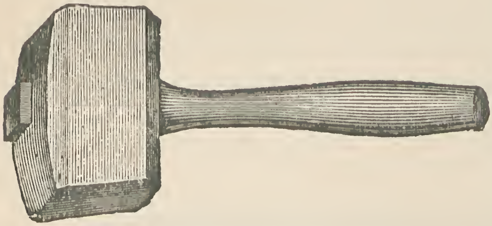


FIG. 33. SQUARE AMERICAN MALLET.

224. When the roots of old trees can be purchased the amateur will find splitting them into logs with the beetle and wedges a capital employment for odd time in winter. He will want three or four iron steel-tipped wedges, which may be procured from most ironmongers at about 4d. per pound, these articles being sold according to weight; and a beetle, or heavy mallet, with a handle of ash, the head being round and encircled at either end with an iron ring to prevent splitting. The head may be of elm or oak. The exercise is invigorating and exhilarating, and the amateur who can indulge in this kind of rough work will soon find pleasure in whirling the heavy beetle over his head, bringing it down with a crash on the head of the wedge, and hearing the creaking, groaning, and splitting of the wood as it slowly yields to the force that is brought to bear on it in rending it asunder.

Beetle and wedges.

225. The tools that are used for cutting as well as striking, whose blow severs or splits as well as drives forward, are the adze and axe, or hatchet. The adze is not likely to be required by the amateur; it is used chiefly by shipwrights in ship building, and sometimes by the carpenter. It is also used in dressing logs of wood or trunks of trees into a rough square shape or taking off protuberances at the butt of the trunk of a tree, so that it may lie conveniently on the cross pieces over a saw-pit for cutting into planks,

Adze, and its uses.

etc., with a cross-cut saw. Fig. 34 shows a common form of the adze, and from this it may be seen that the cutting edge is at right angles to the handle, and that it is used something after the manner of a hoe, the operator standing on the wood and chipping away the surface, bringing the edge of the blade towards his foot at every blow he makes. Shipwrights often inflict severe wounds on their feet with this tool, whose edge to be of any use at all must be well-nigh as keen as a razor.

FIG. 34. THE ADZE.

FIG. 35. ENGLISH HATCHET.

Axe or hatchet. 226. It is with the axe or hatchet that the amateur artisan is more immediately concerned, and this is a tool that he cannot do without, for it may be made useful in a variety of ways. In framing timber together it can be used as a hammer, instead of the heavy carpenter's hammer, which the amateur need not place among his tools; and for sharpening stakes or cutting down timber to the size required in the rough, or for splitting pieces of wood, it is invaluable. It should be kept well sharpened, for a blunt axe is useless for any purpose, as far as cutting is concerned, except splitting firewood.

English hatchet. 227. The form of hatchet in common use among English carpenters and joiners is that which is shown in fig. 35, the American hatchet being represented in fig. 36. The blade of this hatchet is somewhat longer than that of the English hatchet, and the projecting hammer-head at the back is longer, which is an advantage. With regard to prices, carpenters' adzes range from 3s. 3d. to 3s. 9d., according to size, and the best Kent axes from 2s. 6d. to 4s. Good axe heads may be bought by weight, at 1s. 1d. per pound, and ashen handles from 4½d. each. The common axes, which are sold at prices from 1s. to 2s. each, are for

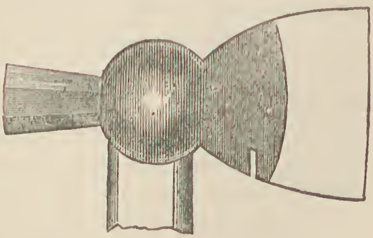


FIG. 36. AMERICAN HATCHET.

the most part useless, except for cutting up fire-wood. The American axes which have a cast head and steel blades are sold at 2s., $1\frac{1}{4}$lbs. in weight; and 2s. 4d., $1\frac{1}{2}$lbs. in weight, by Messrs. Churchill and Co. The smaller size will be found most generally useful by amateurs. The axe usually called a tomahawk by ironmongers is of little use for cutting or chipping wood, although its peculiar wedge shaped form renders it well adapted for splitting wood; it is sometimes called the Canada wedge axe. There are many varieties of axes in use, but those which have been described are most commonly used in carpentering. For felling trees the blade of the axe is longer and narrower in proportion, and partakes more of the form of the wedge than the ordinary hatchet.

American axe.

228. It cannot be too strongly insisted on that the amateur should never use any tool or allow it to be used for any other purpose than that for which it is primarily intended. For example, a hatchet will often be taken, if it can be got at readily, for cleaving firewood or chopping boxes, and the consequence is that the edge is utterly spoiled for carpentering, until the tool has been sharpened and put in order. Screwdrivers, and even chisels, are sometimes taken to prise up the nails with which carpets have been nailed down. In short, to prevent these and similar misappropriations of his tools, which he should be chary of lending, if he wish to keep them in good order, the amateur should

Tools should be kept under lock and key.

Have a door to his workshop secured with lock and key, and be careful always to keep the door locked and the key in his pocket.

229. We must now proceed to *Rasping Tools*, or tools which act by abrasion or rubbing away the material to which they are applied. This will be readily understood when it is considered that the separation of a piece of wood by sawing is effected by the disintegration or continual wearing away into small fragments, technically called sawdust, of a layer of wood, equal in thickness to the extreme width between the teeth of the saw from outside to outside, against which the teeth of the saw are constantly acting until the division has been effected. Rasps and files are also tools which come under this category.

Rasping tools.

230. The saws with which logs and timber of all shapes and sizes is sawn into scantlings, boards, etc., are broad blades of steel with large coarse teeth, such as circular saws and the broad pit saws—with a handle fixed at one end, and a movable handle wedged to the saw blade at the other end — with which timber is cut into planks or any desired scantling by sawyers in

Saws: their nature and operation.

a sawpit. Cross-cut saws are saws with a socket at either end in which a handle is placed, when in use, by means of which the saw is drawn backward and forward *across* the trunk of a tree until it is cut asunder.

231. Circular saws are chiefly used in sawmills, but it is possible to fit a small light circular saw to the carpenter's bench, by means of which much work may be speedily done, though it must of necessity be light work, as the saw itself must be worked by hand or foot, by turning a handle or by pressure on a treadle. We shall have more to say about circular saw action in connection with the bench when touching specially on this part of our subject. A small cross-cut saw the amateur may occasionally find useful, especially if he be in the habit of buying timber to cut into logs for firing; a saw of this kind 4 feet in length costs about 15s. new, but one sufficiently good for ordinary purposes may be occasionally picked up second-hand for half the money. Small circular saws, ranging in diameter from 4 inches to 12 inches, may be bought at from 4s. to 13s., according to size; larger ones from 1 foot to 3 feet at from 13s. to 96s. A saw more than 12 inches in diameter would be useless to the amateur, as it would require at least horse-power to drive it with any effect. Fig. 37 shows

Circular saws.

Cross-cut saws.

FIG. 38. CROSS-CUT SAW.

FIG. 37. CIRCULAR SAW.

the shape of the circular saw, and fig. 38 that of the cross-cut saw. For heavy work, excellent saws of these descriptions are made by MESSRS. TAYLOR BROTHERS, *Adelaide Works, Sheffield*, who supply a cross-cut saw 4 feet long for 12s., in German steel, and 13s. in cast steel; and circular saws from 4 inches to 12 inches, at from 4s. 6d. to 16s. A speciality in Messrs. Taylor's saws is that they are perforated above the notches, which serves to guide the file in sharpening, keep the teeth uniform, avoid fracture, and prevent expansion. Regulleting is saved by the perforations, and there is only half the labour that is involved in sharpening a solid blade. Another excellent feature in Messrs. Taylor's saws of all kinds is, that they are ground thinner towards the back, thus saving much friction in sawing.

232. There are many kinds of saws in addition to those that have just been mentioned ; but those which the amateur artisan will most require are the *Hand Saw, Tenon Saw, Dovetail Saw, Key-hole Saw, and Frame Saw.* These are sufficient for all ordinary work. To these, in order to save wear and tear of the hand saw, a saw called a rip, or ripping saw may be added. This saw has large triangular teeth, and is used for sawing along the grain. It is therefore useful for sawing planks, deals, battens, and boards, the way of the grain ; the work being done more expeditiously with a rip saw than a hand saw.

Saws required by amateurs.

233. The *Hand Saw* is generally useful, and will, as it has been said,

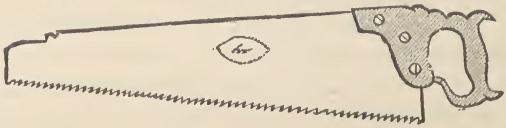


FIG. 39. ORDINARY HAND SAW.

serve the purpose of a rip saw or panel saw, a finer kind of saw used by joiners. Two kinds of hand saws are represented in the annexed illustration. Fig. 39 is the ordinary hand

Hand saw.

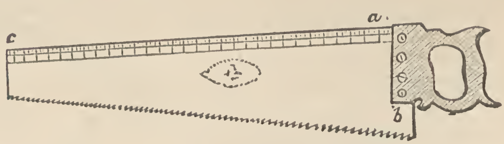


FIG. 40. COMBINATION HAND SAW.

saw which has been in use for years. Fig. 40 represents what is called a "combination saw," as, in this one tool, three or four tools hitherto perfectly distinct and separate are united. It will be noticed that the edge *a b* of the handle, is at right angles to the edge *a c* of the blade ; thus fitting the saw to act as a square. The edge *a c* will also serve as a measuring rule, being graduated in inches and parts of inches, and measuring 24 inches in length from *a* to *c*, and, being perfectly straight, it may further be made useful as a straight-edge. These saws may be had of Messrs. Churchill and Co. for 10s. 8d. each, or with plumb and level attachment for 12s. 8d. Ordinary hand saws with blades 26 inches long, may be had at prices varying from 2s. 6d. to 6s. About 4s. will always purchase a good and serviceable hand saw.

Combination saw.

234. The *Tenon Saw*, shown in fig. 41, is used more especially for cutting across the grain of the wood, and leaves the surface of the wood that is divided by it as smooth as is possible when the nature of the operation is considered. The blade is of necessity thin and fine, and in order to keep it straight when in use, it is inserted into a back of iron or brass. It is worked by means of a handle differing in form from that of the hand saw as may be seen by comparing the illustrations. A tenon saw to be really useful, should be from

Tenon saw.

FIG. 41. TENON SAW (DISSTON'S MAKE).

14 inches to 18 inches in length. Saws of this length as supplied by Messrs. Churchill, with beech handles, range in price from 4s. 8d. to 6s., and with apple handles, Disston's make, from 7s. to 9s. These prices may appear high to the amateur, but it is always better to get good tools and give a fair price for them ; it is far cheaper in the end, and better work can be done with them.

235. The *Dovetail Saw* and the *Sash Saw* are nothing more than tenon saws of small size, being identical with these in shape and make. They range from 8 to 12 inches in length. The medium size, 10 inches long, will be found most useful : the price of a saw of this size varies from 3s. 4d. with beech handle, to 5s. with apple handles, Disston's make.

Dovetail saw and sash saw.

236. The *Keyhole Saw* consists of a long narrow movable blade as shown in fig. 42. A is a pad or handle of hard wood, mounted with a brass end or cap B. The handle is pierced throughout with a narrow slit sufficiently large to allow of the easy passage of the saw. The brass cap is pierced in the same way, and

Keyhole saw.

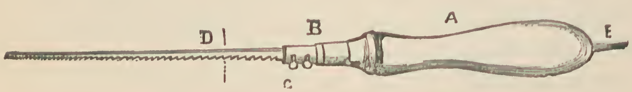


FIG. 42. KEYHOLE SAW AND HANDLE.

within it is an iron plate which is pressed against the saw blade when in use, by screwing up the two screws at C. When not in use the screws are relaxed, and the blade thrust back into the pad ; the top projecting about as far as the dotted line D ; and the other end, which

is sharp and pointed, projecting beyond the end of the pad as at E. When in use care should be taken to tighten the screws as much as possible, lest the saw should slip back and an ugly wound be inflicted by the pointed end on the palm of the hand. Pads in beech, with saw complete, cost from 1s. 3d. to 1s. 6d. each, in ebony or hard wood from 2s. 3d. to 2s. 6d. each ; pad saws cost from 4d. to 6d. each, and the amateur should always have an extra one or two by him to replace the one in use if he break it or bend it past straightening again, as he may do occasionally. The keyhole saw is useful for cutting out curved work, and rough coarse fretwork may be done with it and perforated work generally for rough carving.

Bow or frame saw.

237. The *Bow* or *Frame Saw* is a narrow, slender, finely notched blade fixed in a frame of wood as shown in fig. 43. The ends of the blade are fixed in two handles at the lower part of the frame, and it is tightly stretched so as to render it perfectly rigid by twisting a piece of catgut or thong looped over the upper ends. When the upper extremities are thus drawn together, the lower ends are of necessity forced apart and the blade is tightened. A bow saw and frame costs from 3s. to 4s., the blades being from 3d. to 6d. each. In fig. 44 an American modification of the frame saw is shown, called the arch frame wood saw. The frame and blade, 30 inches long, is supplied complete by Messrs. Churchill and Co. for 4s., the frame without the blade for 1s. 8d. The frame saw shown in fig. 44 is of course much larger than that shown in fig. 43 : it is commonly used on the Continent instead of the hand saw, as far as the frame will permit. An amateur handling it for the first time would find it difficult and awkward to use, but it is said that those who are accustomed to it prefer it to the hand saw.

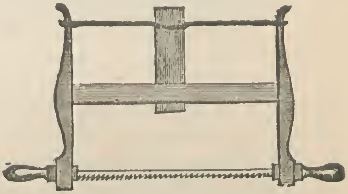


FIG. 43. BOW OR FRAME SAW.

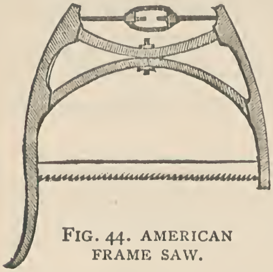


FIG. 44. AMERICAN FRAME SAW.

Rasps for wood.

238. *Rasps*, generally speaking, are used in carpentry for cutting away or smoothing wood, or for wearing away the sharp edge left in a circular hole that has been cut out with the keyhole saw, so as to impart a bevel to it sloping from above to the under part. A rasp is flat on one side and slightly convex on the other,

and covered with fine projecting points beaten up by a mallet and punch. They are of different degrees of roughness, and cost from 4d. to 1s. 6d. each according to length, etc.

239. *Files* are used for cutting metal and sharpening saws. The

FIG. 45. THE RASP (FOR WOOD).

surface of the file is ridged with fine lines cut into the metal. Fig. 45

FIG. 46. THE FILE (FOR IRON).

FIG. 47. SECTION OF FILES.

Files for metal.

shows the general form of the rasp. Fig. 46 that of the triangular file, and fig. 47 the transverse sections of files most generally used: A being the triangular file, with three faces tapering to a point; B the round or "rat-tailed" file, for cutting or enlarging round holes in metal; and C the flat or warding file, useful in filing the wards of a key, etc., or cutting a deeper head to a screw. Files are also used in finishing fret-work and wood carving, and may be had for this purpose at 3d. each or assorted in sizes at 2s. 6d. per dozen, assorted. Files for working in metal cost about 3d. or 4d. each, saw-files for sharpening saws from 3d. to 6d. each, according to the size of the teeth of the saw on which they are intended to operate, the larger and deeper teeth taking the more expensive files.

Various forms of files.

240. *Paring tools*, or tools which are used for cleaning away the rough, ragged surface left by the teeth of the saw and rendering wood smooth and even, or otherwise for cutting wood into various forms and shapes, are frequently called edge tools, as they present a sharp, keen edge. Indeed, if they are blunt in the least degree they are not fit for use. Watch an artisan at his work, and you will see him frequently rub his plane-iron or chisel on the oil-stone in order to sharpen it. An amateur, especially a beginner, in nine cases out of ten, either does not think of doing so, or altogether forgets that there is any necessity for it, and this is one of the chief reasons why amateur's work is often so badly done. We have insisted on the need that there is for the amateur to buy none but good tools, and to take care to keep them under lock and key: he must further supplement this by keeping them perfectly clean and free from rust, and learning to whet the edge of each and all cutting tools of this class

Paring tools, or edge tools.

when they show signs of dulness. Special mention of sharpening tools, and the mode of, and appliances for, doing this will be made further on.

Planes necessary to amateurs.

241. The tools that are comprised in the first group of paring tools are Planes. Now of these there are an infinite variety, as formerly, before moulding was made by machinery, every different pattern required a different plane or plane-iron. The planes that are absolutely necessary to an amateur are a jack-plane and a smoothing-plane. To these a trying-plane may be added, as it is most useful for long joints and fine first-class work, match planes for grooving and tongueing, a rebate-plane, and two or three beading-planes for cutting beads of different sizes on the square edge of a board to break joint, and the grooving-plane, familiarly called the "old woman's tooth."

242. It will be as well first to take into consideration the *Jack-plane*

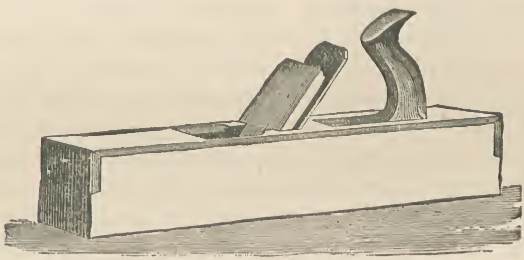


FIG. 48. THE JACK-PLANE.

Jack-plane: its construction and action.

and the smoothing-plane, which, as it had been said, are the two planes most necessary to the amateur. The jack-plane shown in fig. 48 is from 15 to 18 inches long, and 2½ inches broad, and about the same in depth. Near one end is a handle projecting upwards called a "toat," and near the other a hole for the reception of the plane-iron, which is held in its place by a wedge. Planes of this description, and smoothing-planes also, are usually made with double irons; that is to say, of two irons held together by a short screw, as shown in fig. 49. In this, A is the iron with a sharpened edge which takes off the outer surface of the wood in shavings, and B the iron which is attached to it by the screw C. The edge of the iron B, which is slightly bent, is placed at a very short space from the edge of A: it serves to support and

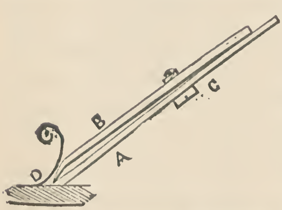


FIG. 49. DOUBLE PLANE-IRON.

strengthen the cutting blade, and turn off the shaving in an upward direction through the hole that is cut in the wood for the reception of the iron as shown at D.

243. The *Smoothing-plane* is different to the jack-plane in shape; being about 8 inches long and 2½ inches to 3 inches broad, in the widest part where the iron issues from the wood, tapering to a width of about 2 inches in front and 1¾ inches behind, so that it may be more easily held in the hand. This kind of plane is shown in fig. 50. The jack-plane is used for taking the rough surface from the sawn timber, and when this has been removed the smoothing-plane is used to make the surface of the wood perfectly smooth and even. These planes are generally made in beech, and cost—the smoothing-plane from 3s. 6d. to 5s., and the jack-plane from 4s. to 5s. The amateur artisan will do well to have a smoothing-plane that is filled with an iron sole or plate extending over the bottom of the plane, but when made in this way the plane of course will cost more.

Smoothing-plane.

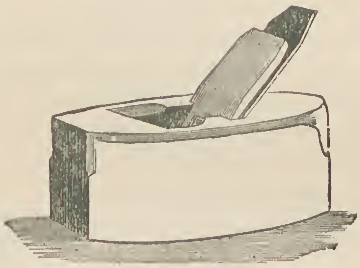


FIG. 50. SMOOTHING-PLANE.

244. *Trying-planes* and *Jointer-planes* differ from the jack-plane in being longer and set with a finer cut. The former is generally from 22 inches to 24 inches long, and costs from 6s. 6d. to 7s. 6d. or 8s.; the latter is from 28 inches to 30 inches long, and costs from 8s. to 9s. The handles of these planes differ in shape from that of the jack-plane, as may be seen from an inspection of fig. 51, in which A represents the toat or horn which forms the handle of the jack-plane, and B the looped handle of the trying or jointer-planes.

Trying-plane.

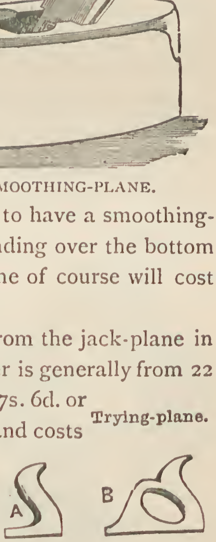


FIG. 51.
TOATS OF PLANES.

245. The great difficulty which is found by most amateurs in working with the plane is to adjust the iron accurately, so that the plane may cut properly and take off shavings of uniform thickness throughout. Again, it is necessary that the iron should project beyond the sole rather more for working some kinds of wood and rather less for others, although the actual difference may be scarcely appreciable. All this occasions much trouble to the amateur artisan, and facility in adjusting and using the plane can only be obtained by a little tuition from a skilled

Difficulty to amateurs in using plane.

mechanic, followed by plenty of practice, if the ordinary planes are used. Of late years, however, some beautiful planes have been brought into use in America, of which the amateur artisan is recommended to avail himself. The great merit of these planes is that they are *self adjusting*, which obviates most of the difficulty to the amateur of which we have been speaking with regard to adjustment. We give six illustrations of serviceable adjustable bench planes suitable for the requirements of the amateur, which are kept in stock and sold by Messrs. Churchill and Co., and which are well worthy the attention even of skilled mechanics.

Bailey's Patent Adjustable Bench Planes.

246. Figs. 52 and 53 are illustrations of Bailey's Patent Adjustable Bench Planes. In these the plane-iron is secured in its position by means of the iron lever, with a cam and thumb-latch at its upper end. A screw passing down into the iron bed-piece below serves as a fulcrum on which the lever acts in clamping down the plane-iron. The lever may be put in position or removed at pleasure without the use of any tool, it being properly slotted for this purpose ; and the pressure required for the best working of the plane can be obtained at any time by driving or slacking the central screw upon which the lever operates. The thumb-screw, located under the iron bed-piece, and just in front of the handle of the plane, works a simple device by means of which the plane-iron can be easily set forward or withdrawn while it is still clamped down to the bed-piece ; and without removing the hands from the plane or the plane from the work, any desired thickness of shaving can be obtained with perfect accuracy. For beauty and style of finish these planes are unequalled, and the great convenience in working renders

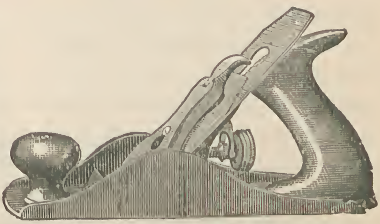


FIG. 52. BAILEY'S ADJUSTABLE SMOOTHING-PLANE.

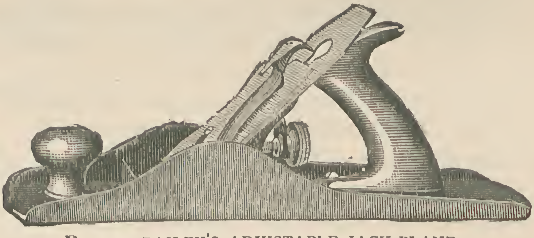


FIG. 53. BAILEY'S ADJUSTABLE JACK-PLANE.

them the cheapest planes in use. Each part, being made interchangeable, can be replaced at a trifling expense. The plane is held by the handle behind with the right hand, and steadied with the left hand, which is placed on the knob in front. Fig. 52 shows the smoothing-plane, and fig. 53 the jack-plane. The prices vary according to length of plane and width of cutter, as follows :—

SMOOTHING PLANES.

No.				£	s.	d.
1.	$5\frac{1}{2}$in. long,	$1\frac{1}{4}$in. cutter	... ...	0	9	6
2.	7 ,,	$1\frac{5}{8}$,,	... ...	0	11	6
3.	8 ,,	$1\frac{3}{4}$,,	... ...	0	12	6
4.	9 ,,	2 ,,	... ...	0	14	0

JACK, FORE, AND JOINTER PLANES.

No.				£	s.	d.
5.	14in. long,	2in. cutter	... ...	0	16	c
6.	18 ,,	$2\frac{3}{8}$,,	... ...	1	0	0
7.	22 ,,	$2\frac{3}{8}$,,	... ...	1	4	0
8.	24 ,,	$2\frac{5}{8}$,,	... ...	1	8	0

It should be said that No. 5 in the above list is the jack-plane ; No. 6 the fore or trying plane ; and Nos. 7 and 8 jointer planes. The American planes, it will be noticed, are not so long as the English planes which bear the same names.

Stanley's Patent Adjustable Planes.

247. In figs. 54 and 55 are shown two of Stanley's Patent Adjustable Planes, which differ somewhat in construction from Bailey's planes, which have just been described, although the general principle is the same. The peculiarity of these planes is that they have a *wrought steel stock*. Being adjusted by the use of a compound lever, they are equally well adapted to coarse or fine work ; and, in addition to this, they commend themselves to amateur artisans for their lightness of weight and the ease with which they can be worked. The smoothing-plane, 9in. long, with a $2\frac{1}{8}$in. cutter, costs 12s.,

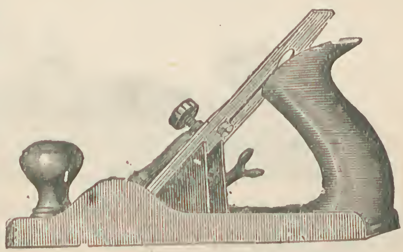


FIG. 54. STANLEY'S ADJUSTABLE SMOOTHING-PLANE.

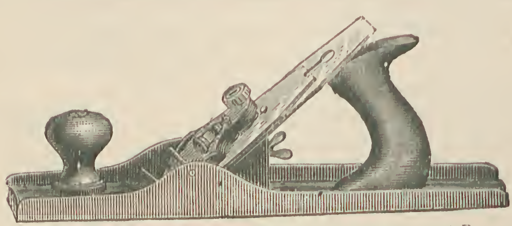


FIG. 55. STANLEY'S ADJUSTABLE JACK-PLANE.

and the jack-plane, 14in. long, with a cutter of the same width, costs 14s. The Stanley planes just described have steel stocks, and the Bailey planes iron stocks ; but there are also Stanley planes with wood stocks,

which may be bought at cheaper rates. Fig. 56 shows a wood smoothing-plane 8in. long, with a 1¾in. cutter, which costs 6s. 6d. A larger plane, 10in. long, with a 2⅛in. cutter and a handle like the jack-plane in fig. 57, costs 8s. 6d. The jack-plane (fig. 39), 15in. long, with a 2⅛in. cutter, costs 8s. 6d.; the fore, or trying plane, 20in. long, with a 2⅜in. cutter, 9s. 6d.; and the jointer plane, 26in. long, with a 2⅝in. cutter, 11s.

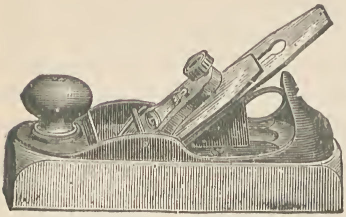


FIG. 56. STANLEY'S WOOD SMOOTHING-PLANE.

Moulding planes, etc., not required by amateur.

248. It has been said that the smoothing-plane and the jack-plane are the two tools of this description that are most necessary to the amateur artisan. He need not go to the expense of a trying-plane, because he is not likely to be doing such joiner's work as will require such a true and accurate edge to the work as when two panels are to be fitted edge to edge, as in large panels, for example. He will buy all his match-boarding ready wrought for use, and all his grooved and tongued timber, so he need not have any match planes unless he has a particular fancy that way. He will not require moulding planes, but he will find it useful to include in his stock a good rebate plane, some beads, an old woman's tooth, and a plough plane, with a set of irons for various widths.

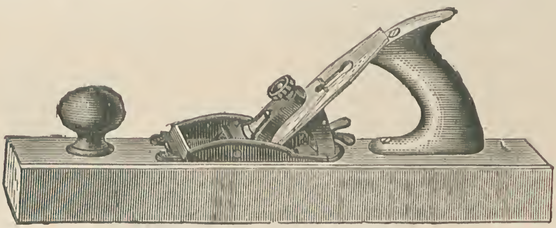


FIG. 57. STANLEY'S WOOD JACK-PLANE.

Rabbet or rebate plane.

249. The rabbet or rebate plane is shown in the accompanying illustration. The iron, it will be noticed, comes out at the side as well as the bottom of the plane, and so the edge of a board can be cut away by it so as to leave an indentation all along its length like a step, so that it may fit over and into another similar

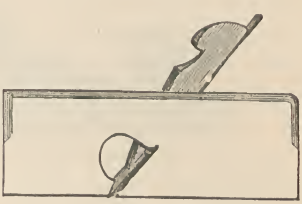


FIG. 58. REBATE PLANE.

indentation cut in the edge of another board. The recess in a sash bar, into which a piece of glass is laid, is a rabbet or rebate. The cost of ordinary rebate planes in beech, as shown in fig. 58, with skew cutters, varying from 1¼in. to 1½in., ranges from 2s. 6d. to 3s. The "old woman's tooth," so called from its narrow projecting cutter, is used for cutting grooves, and may be bought for 1s. 9d. or 2s. Planes for cutting beads may be had for 2s. 6d. each. They range in sizes upwards from ⅛in., increasing by ⅛in. The most useful sizes are ⅛in., ¼in., ⅜in., and ½in., but larger sizes may be had if required. A plough plane, with screw top and eight irons, may be had for from 18s. to 20s. Besides these there are many planes of different forms used for different purposes, as fillisters, sash fillisters, dado planes, compass planes, fluting planes, etc., but the description of them would take up too much space. They are, moreover, expensive, and to purchase them would require a far greater outlay than most amateurs would either be able, or indeed care, to make.

Old woman's tooth.

Fillisters of various kinds.

250. The spokeshave and the drawing-knife are the tools that are comprised in the second division of paring tools. The drawing-knife is useful for reducing the size of any piece of wood that it may be inconvenient to cut down in any other way. The spokeshave, as its name implies, may be used for imparting a smooth surface to the spokes of wheels, but it is also useful for smoothing down any surface that is not required to be perfectly flat. Thus, a bevelled edge may be given to a round hole of any large size cut in a piece of wood. The drawing-knife is always worked towards the operator, but the spokeshave may be used in a direction either towards or from the person who is using it.

Spokeshave.

FIG. 59. DRAWING-KNIFE.

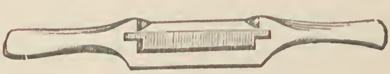


FIG. 60. SPOKESHAVE.

251. The drawing knife is shown in fig. 59. It is simply a long and rather thick blade, perfectly rigid, but having a keen knife-like edge. On either side is a projecting spike, which is turned at right angles to the back of the blade, and inserted into a wooden handle. It is an instrument that does its work quickly and effectually when some degree of force is applied to it. Prices range, according to size, from 2s. to 3s. 6d. The spokeshave has a thick and slightly curved blade with a keen edge, and projecting

Drawing-knife.

arms on either side which are bent at right angles to the flat of the blade, and inserted into a beech-wood handle, or rather a double-handled piece of beech wood, as shown in fig. 60. The part that is shown in the drawing is placed against the wood, and the shavings pass under the blade, between it and the wood, and come out through the hollow shown in the upper part of the illustration. The stocks, or handles, are usually made of beech. Prices are according to length of edge of blade, namely, 2½in., 1s. 6d.; 3in., 1s. 8d.; 3½in., 2s.; and 4in., 2s. 4d. They may be purchased for less money, but in buying tools it is always better to give a good price for them, for inferior articles are well-nigh useless, and cause disappointment, often giving the amateur a distaste for the work that he has taken in hand.

American iron spokeshave.

252. Some excellent iron spokeshaves have been introduced from America, and may be bought of Messrs. Churchill and Co. The cutters are made of the best English cast steel, tempered and ground by an improved method, and are in perfect working order when sent from the factory. Fig. 61 shows a Double Iron Straight Face Spokeshave, 16 in. long, with a cutter of 2⅛in. (which is the length adopted for all cutters in carpenter's spokeshaves made in America), and raised handles. The price of this tool is 1s. 3d., and for the same money a similar spokeshave may be had with straight handles. Spokeshaves, with adjustable mouth and either raised or straight handles, may be had for 1s. 7d. each. The Model Double Iron Spokeshave with hollow face costs 1s. 3d. There is another kind with two cutters 1½in. wide, one hollow or curved, and the other straight, which costs 1s. 1d.; but as neither cutter can be in the middle of the stock, where it ought to be, the tool must be some-

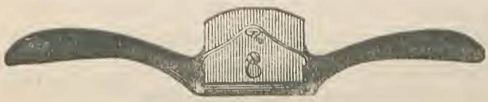


FIG. 61. DOUBLE IRON STRAIGHT-FACE SPOKESHAVE.

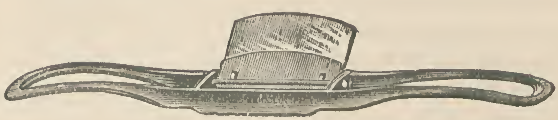


FIG. 62. REVERSIBLE SPOKESHAVE.

what one-sided to work. Fig. 62 shows the Reversible Spokeshave, which can be worked to and from the person using it without changing position. This useful tool, which has raised handles and is furnished with two straight cutters 2⅛in. long, costs 2s. 2d.

253. The third and last division of paring tools comprises chisels

and gouges. In reality the plane in its simplest form, as seen in the jack-plane and smoothing-plane, is nothing more than a chisel of considerable width set in a block of wood, which serves as a guide, and by means of which the operator is enabled to work the tool with greater ease and accuracy. Moulding and fluting planes, as well as beads, grooving planes, ploughs, etc., may with equal propriety be looked upon as modifications of the gouge. A chisel is a flat and thick piece of steel, of which the cutting end is ground to a bevel, in order to obtain a keen edge, while the other is fashioned into a tang, with a projecting shoulder, which fits close against the wooden handle into which the tang is inserted. The gouge differs from the chisel in being hollow instead of flat. Chisels are distinguished as firmer chisels, paring chisels, mortising chisels, and turning chisels. It must be said, however, that the last-named variety differs from the other kinds of chisels, in being ground to a bevel on both sides instead of one side only. Gouges are distinguished as firmer gouges and turning gouges. The main point of difference between them is that the former are sharpened on the outside on the bevel, and the latter on the inside.

Chisels and Gouges.

Chisels, how distinguished.

Gouges, how distinguished.

254. In the annexed illustrations are shown the various forms of chisels used in Carpentry and Joinery, and that of the gouge. In fig. 63 is shown the *Firmer Chisel*, or ordinary carpenter's chisel, turned in such a way as to show the width of the blade and the bevel. In fig. 64 a representation of the same kind of chisel is shown turned so as to show the side or thickness of the blade, and the angle of the bevel by which the cutting edge is formed. The only difference between firmer chisels and paring chisels are that the former are shorter and thicker in the blade, while the latter are shorter and thinner. Firmer chisels vary in width from ⅝in. to 2in., and paring chisels from ¼in. to 2in. The latter are chiefly used by pattern makers for fine and more delicate work, while the former are better adapted for the rougher work of the carpenter and joiner.

Firmer chisels.

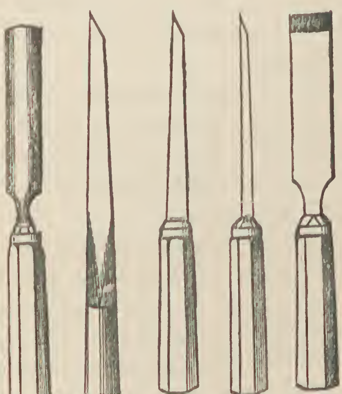


FIG. 67. GOUGE. FIG. 66. FIG. 65. MORTISE CHISELS. FIG. 64. FIG. 63. FIRMER CHISEL.

Mortise chisels. 255. It will be noticed that while these chisels are contracted in width between the broad flat blade and the shoulder, the mortise chisel, shown in fig. 65 so as to show the side, is broadest at the shoulder, and narrows gradually until the bevel is reached. This is done in order to impart extra strength to the tool to bear the heavy blows of the mallet in mortising. Chisels of this description are made varying in width from ⅛in. to 1in. Some mortise chisels are made with a socket, as in fig. 66, into which a short beech handle is fitted. Chisels thus made and handled are used for heavy work.

Turning chisels. 256. The peculiar forms of the turning chisel will be shown in the chapter on Turning. They are of various widths, and longer than even the paring chisels, generally speaking. For turning soft wood the edge of the turning chisel is bevelled on both sides, as it has been said; but for turning hard wood a much shorter chisel is used with a bevel on one side only, like that of the ordinary chisel, but with not so great a slant. The double bevel edge has the effect of throwing off a clean shaving from the wood when revolving in the lathe, while the blunter single bevel edge acts more like a scraper, and does not take off clean shavings.

Gouges. 257. In fig. 67 the shape of the gouge is shown, which resembles a chisel bent into a curved form, so that the section of the blade would resemble a crescent. Gouges are made in sizes varying from ¼in. for turning gouges, and $\frac{5}{16}$in. for firmer gouges, to 2in. for both kinds. Turning gouges are longer than firmer gouges, and are used by turners for roughing down their work in the lathe.

Cold chisel. 258. It may be mentioned that the tool called a *cold chisel* is a long piece of steel, levelled on both sides at one end to a blunt edge, used by carpenters and others to knock out a hole in a wall of stone or brick for the insertion of a wedge, the end of a piece of timber, etc.

Chisels and gouges required by amateur. 259. About half-a-dozen chisels and the same number of gouges will be the utmost number that the amateur will require; and, for both chisels and gouges, the widths to be selected may be placed at ⅜in., ½in., ¾in., 1in., 1¼in., and 1½in. The ordinary carpenter's or firmer chisels should be purchased first of all. A few paring chisels can be added to the stock at any time if required. Sets of chisels assorted may be purchased at from 5s. to 7s. 6d., and sets of gouges from 6s. 6d. to 8s. For ordinary mortising the firmer chisel will be sufficient; but one or two socket

chisels will be found useful, and, for any very narrow work, one or two mortise chisels or sash mortise chisels of the narrowest widths will be necessary.

Prices of chisels and gouges.

260. The following are the sizes and prices of chisels and gouges taken from the price list of MR. A. S. LUNT, *Tool and Cutlery Warehouse*, 297, *Hackney Road, London, E.*:—

Width in inches.	Firmer Chisels.	Paring Chisels.	Turning Chisels.	Mortise Chisels.	Sash Mortise Ch.	Socket Chisels.	Firmer Gouges.	Turning Gouges.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1/8	—	0 7½	0 6	—	1 6	—	—	0 8
3/16	0 4½	—	—	1 2	1 6	—	0 5½	—
1/4	0 5	0 8	0 6½	1 3	1 7	1 0	0 6	0 9
5/16	0 5½	—	—	1 4	1 9	—	0 6½	—
3/8	0 5½	0 8½	0 7½	1 6	1 10	1 0	0 6½	0 10
7/16	—	—	—	1 8	2 0	—	—	—
1/2	0 6	0 9½	0 8	1 10	2 2	1 1	0 7	0 11
5/8	0 6½	0 11	0 9	2 2	—	1 2	0 8	1 0
3/4	0 7½	1 0	0 10	2 11	—	1 3	0 9	1 2

Width in inches.	Firmer Chisels.	Paring Chisels.	Turning Chisels.	Mortise Chisels.	Sash Mortise Ch.	Socket Chisels.	Firmer Gouges.	Turning Gouges.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1	0 8	1 2	11½	3 7½	—	1 4	0 9½	1 4
1⅛	0 10	1 4	1 1	—	—	1 6	11½	1 6
1¼	0 11	1 7	1 3	—	—	1 8	1 1	1 8
1⅜	1 0	1 9	1 5	—	—	1 9	1 2	2 0
1½	1 1	1 11	1 7	—	—	1 10	1 4	2 3
1⅝	1 3	2 1	1 9	—	—	—	1 6	2 6
1¾	1 4	2 3	1 11	—	—	—	1 8	2 8
1⅞	—	2 6	—	—	—	—	—	—
2	1 8	2 10	2 3	—	—	—	2 0	3 3

If with round ash handles and brass ferules, 2s. per dozen extra, or with box octagon handles, 5s. per dozen extra.

Boring tools.

261. The tools comprised in the first division of *boring tools* are bradawls, gimlets, and augers. These tools are, for the most part, extremely simple in construction, the bradawl being a piece of steel sharpened at the end and fixed for convenience of use in a wooden handle; and the gimlet a piece of steel so fashioned at one end that it may take hold of, and cut its way into, timber, and having a small piece of wood attached crosswise at the other end, which serves as a lever to turn the steel shank of the tool, and press it into the wood. The auger is only a gimlet on a large scale, the cross handle being turned by the operator with both hands, which are transferred from end to end of the handle at every half-turn of the tool. The gimlet is held and turned by the right hand only. The mode and method of holding and working these and other tools will be described fully in the next chapter.

Bradawls: their varieties.

262. The bradawl and the gimlet are represented in the accompanying illustration, the shape of the former when handled being shown in figs. 68 and 69. The bradawl varies in size or diameter of the steel shaft from $\frac{1}{16}$in. to ⅛in. or $\frac{3}{16}$in. Smaller sizes are made, but these are generally called sprig tools; the term bradawl being more strictly applied to the longer sizes only. Whether it be large or small, the bradawl is a round piece of steel fitted with a

shoulder and tang at one end, which is inserted into a handle generally of beech or ash, and of the form shown in the illustration. The shoulder abuts against the handle, as in the case of the chisel and gouge; and, to keep the handle from splitting when the tang is driven into it, it is furnished with a narrow brass ring or ferule. The end of the steel shaft thus handled is ground down on either side so as to form a Λ shape, as shown in fig. 68. Either side of the shaft when ground presents the appearance shown in fig. 69. The legitimate purpose of the bradawl is to bore holes in wood so as to ensure the passage of a nail or screw in the right direction, and also to render its entrance into the wood more easy; but occasionally for driving in or withdrawing small screws, especially those by which handles of doors are secured to the spindle, a large bradawl may be used conveniently as a screwdriver.

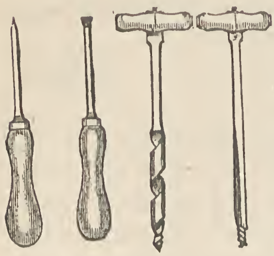


FIG. 68. FIG. 69. FIG. 70. FIG. 71.
BRADAWLS. GIMLETS.

Gimlets: their varieties.

263. *Gimlets* are of two kinds, plain and twisted. The form of the twisted gimlet is shown in fig. 70. In this kind a deep *spiral* groove runs upward from the screw point about half-way up the shank. It possesses two advantages over the plain gimlet shown in fig. 71, and these are:—that it can be worked with more ease, the wood that is cut away being forced up the groove as the tool penetrates deeper and deeper into the wood; and that it makes a cleaner hole. The screw-point in this and the plain gimlet is to give the tool a firm holding in the wood at entrance, and to ensure its regular progress in penetrating the timber. The plain gimlet is a steel shank with a small screw-point and a *straight* groove running more than half-way up its length. This kind of gimlet is more apt to break or twist in hard wood than the spiral or twisted gimlet; and when it is necessary to bore a deep hole, the friction arising from the wood that is cut away becoming tightly packed within the straight groove renders the tool somewhat difficult to work, as any one may prove to his own satisfaction by boring a hole in a piece of oak with a plain gimlet. The head of the gimlet consists of a piece of boxwood usually turned in the form shown in the illustration. The steel is squared at the upper end, and tapers away to a fine point. The squared part keys, as it were, into the handle, and the thin end is rivetted over a small disc of copper. Thus the cutting or boring part of the tool is securely fixed to the handle, and any chance of the

handle slipping round, as it would have done, had not the steel shaft been squared at the top, is prevented.

264. Twisted gimlets may be bought at 3s. per dozen, or at from 2d. to 6d. each, according to size, and the plain or shell gimlets at 2s. 9d. per dozen, or at from 2d. to 4d. or 5d. each, according to size. Bradawl blades, without handles, cost about 8d. per dozen assorted, or 1s. 6d. a dozen with handles. Separately the blades are sold from 1d. to 1½d. each without handles, or from 1½d. to 3d. each with handles, according to size. Large flooring bradawls, handled, cost from 3½d. to 4d. each. The amateur artisan will find three or four gimlets of various sizes, and the same number of bradawls, as many as he will require, and to these should be added a flooring awl, which will also serve the purpose of a small screwdriver. The cheapness of these tools, however, will enable any amateur carpenter to furnish himself with a complete set assorted, if he wishes to do so.

Cost of bradawls and gimlets.

265. The auger, as it has been said, is a gimlet on a large scale. There are two kinds of augers, distinguished as shell augers and screw augers. The shell auger corresponds with the plain or shell gimlet, and the screw auger with the twisted gimlet. The tools are useful for boring large and deep holes, especially for the passage of a screw-bolt and nut; but the shell auger may be made useful in mortising, especially if the amateur has not a bit brace or stock and bit at his disposal. In the accompanying illustration, fig. 73 shows the end of the shell auger, and fig. 72 that of the screw auger. Sometimes the auger is secured, like the gimlet, to a cross-handle of wood; but it is also squared at the end so as to key into a handle, as shown in fig. 75, or formed into a loop through which a handle may be passed, as in fig. 74. It is useful to have four augers calculated to cut holes ½in., ¾in., 1in., 1½in. in diameter. A kind of auger called a hollow auger is made, but this tool is used more especially by coach-builders and chair-makers, and is comparatively useless to amateurs. There is also a form of auger known as the ladder or taper auger, which will bore a hole like a funnel—large at the top and small at the bottom; but this the amateur is not likely to require. The following are the prices of augers according to the diameter of hole they will bore:—

Augers: their varieties.

FIG. 72. SCREW AUGER.

FIG. 73. SHELL AUGER.

FIG. 74. FIG. 75. CONTRIVANCES FOR HANDLING AUGERS.

Prices of augers.

Description.	$\frac{3}{8}$in.	$\frac{1}{2}$in.	$\frac{5}{8}$in.	$\frac{3}{4}$in.	$\frac{7}{8}$in.	1in.	$1\frac{1}{8}$in.	$1\frac{1}{4}$in.	$1\frac{1}{2}$in.	$1\frac{3}{4}$in.	2 in.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Shell Augers	0 8	0 8	0 10	1 0	1 2	1 4	1 6	1 8	1 10	2 4	2 10
Bright Screw Augers with Eyes	1 8	1 9	2 0	2 3	2 6	2 9	3 2	3 8	4 2	5 0	5 10
Patent American Augers with Eyes	—	2 9	3 0	3 6	4 0	4 6	5 0	5 6	6 6	—	—

266. The bit-brace, or stock-and-bit, is the principal tool in the second division of boring tools, and, indeed, the only tool of this kind with which the amateur artisan need concern himself.

Bit-braces and drill.

There are breast-drills, fitted with a plate to hold against the breast, steadied with a handle held in the left hand, and having a chuck at the further extremity in which the drill is placed and caused to revolve at a rapid rate by a large toothed-wheel working in a smaller wheel, the former being turned by a handle held in the right hand. These are, however, more suitable for working in iron, but they are used for working in wood, especially by carriage builders. An excellent drill of this description, called the Patent Breast Drill, is sold by Messrs. Churchill and Co. for 12s. The best kind of tool for use in this drill is the Morse Bit Stock Drill, of which there are many sizes, varying in diameter from $\frac{1}{16}$ to $\frac{1}{2}$in. by regular increase of 1-32nd of an inch, and ranging in price from 7d. to 3s. 4d. each.

Patent Breast Drill.

267. To return however to the bit-brace, or stock-and-bit, this was once one of the most expensive tools that were made, and its price prevented many an amateur possessed of but slender means from purchasing one. Now it can be obtained so cheaply that no amateur has any reasonable excuse for being without one. The general principle of the machine may be best explained by aid of fig. 76, in which A represents a piece of iron bent into the form of a crank. Now it is plain that if the end B of the crank be fitted by means of a collar into the flat disc D, so that it may revolve freely within it without escaping from it, and a sharp cutting tool be attached to the end of C, so as to be practically immovable and merely an extension of the extremity C,—the operator, by holding the disc D against his breast and turning the crank with his right hand, applied to it at A, may, by the force given to the cutting tool by the pressure of his body against the disc and the rotatory motion imparted to it by turning the crank rapidly, cause the tool to penetrate deeply and quickly into any kind of wood to which it may be applied. This is the principle on which the bit-brace acts, and a

Bit-brace, or stock-and-bit.

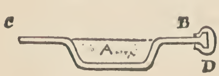


FIG. 76.
PRINCIPLE OF BRACE.

knowledge of this will help the operator wonderfully in the use of the tool. The pressure is transmitted directly in the dotted line shown in the diagram, and must be sufficient to overcome any want of steadiness that might otherwise be caused by the rotatory motion of the crank.

268. As the old and often beautifully made and finished wooden brace is now almost entirely superseded by the plainer but equally serviceable iron brace, there is no necessity for giving a representation of it in these pages. The wood-work was merely an expensive substitute for the iron crank that is now used, and its costliness arose chiefly from the unnecessary time and care that was expended on its construction. One end, as shown in the above diagram, worked freely in a knob; the other was fitted with a box, in which the squared end of the bit was thrust. A notch was also cut across one side of the square end, into which a catch dropped when the bit was pushed into the box, securing it from slipping out until the catch which acted by a spring was raised by pressing a projecting button on the outside of the cap, thus enabling the operator to withdraw the bit. The wooden brace ranges in price from 9s. to 25s., or thereabouts, according to the kind of wood of which it is made and the fittings. The bits are extra, and are sold at about 5d. each, or about 12s. 6d. for a full set of thirty-six. Fig. 77 in the accompanying illustration of iron braces shows the common socket brace, with a thumbscrew for retaining the bit in the socket. An 8in. brace of this description may be, or ought to be, purchased for 1s. 4d., and a 10in. one for 1s. 8d., of any ironmonger who keeps this class of goods.

Modern iron brace.

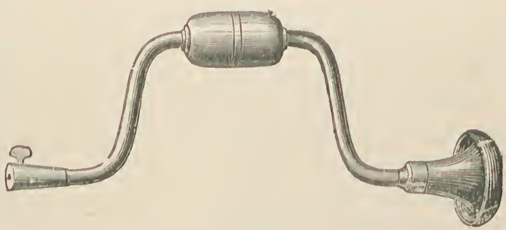


FIG. 77. COMMON SOCKET IRON BRACE.

269. These are excellent braces for the money, and if the amateur cannot afford a better one, he should get one of these rather than be without one; but it will be readily seen that the thumbscrew action for the retention of the tool in the socket is liable to get strained and put out of order by the very nature of the work which is done by the brace and bit. The brace which is recommended for the amateur's use, being alike cheap and serviceable, is "Barber's Patent Bit-Brace" (fig. 78), which is fitted with an expanding

Barber's Patent Bit-Brace.

chuck that can be opened and secured at pleasure by a simple contrivance; and from this peculiarity in its construction will hold shanks of bits, reamers, counter-sinkers, etc., of all shapes and sizes, and hold them true without fitting. The convenience of this will be manifest when it is remembered that the old-fashioned brace will receive only such shanks of bits as are made to fit the box, while the chuck of the Patent Bit-Brace will receive and hold fast any kind of bit, be it what

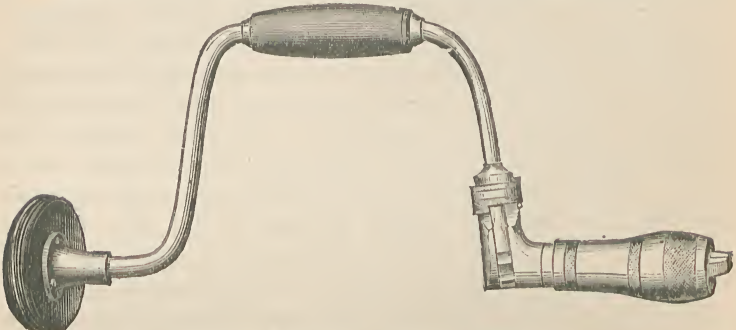


FIG. 78. BARBER'S PATENT BIT-BRACE.

it may. Thus when the amateur artisan possesses a Patent Bit-Brace, he may purchase any kind of bit, whether new or second-hand, knowing that he will be able to use it; whereas in the old wooden brace pretty much filing and fitting might be necessary to reduce the shank to the size of the box or socket if it were too large, while if it were too small, and so fitted loosely, the bit would be useless. The prices of these braces are as follows, the ball that is mentioned being the piece of wood that is fitted over the middle part of the bend of the crank for convenience in grasping it with the hand in order to turn the brace.

Description.	8in.	9in.	10in.	12in.
	s. d.	s. d.	s. d.	s. d.
Lignum vitæ Head and Rosewood Ball	6 3	—	7 0	8 0
Hardwood Black Head and Ball	3 9	—	4 3	—
Hardwood Head and Ball	3 2	3 6	3 10	—
Brace fitted with Ratchet	9 0	—	10 0	—

For all ordinary purposes the 9in. brace, with hardwood head and ball, will be found to be cheap, useful, and serviceable.

Angular bit stock. 270. The common brace bores a hole in a direction perpendicular to the breast of the operator, or in a straightforward direction. There is, however, what is termed an angular bit-stock, represented in fig. 79, which can be used in any brace, at any

degree of angle for boring in a corner, which it will do as readily as a

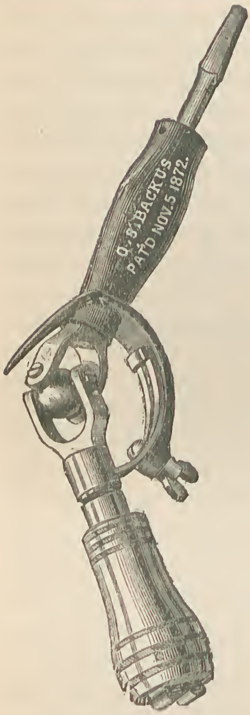


Fig. 79.
ANGULAR BIT-STOCK.

common brace bores straight, the angular borer turning clear around without stopping to ratchet. It is in reality a contrivance for effecting a change in the direction of the pressure exerted. The pressure, as was shown in the diagram in section 267, acts in a straight line running from the centre of the head and the centre axis of the bit. In the angular bit stock the square shank shown, in the upper part of the engraving, is thrust into the shank, and motion imparted to the bit, which is placed in the chuck at the other end, by the ball or handle between the key and the ball-joint, at which the change in the direction of the power takes place. The degree of angle is regulated by the metal plate and arc on the right of the ball-joint, the requisite angle being maintained by tightening the thumb-screw, which must be again relaxed when any alteration of direction is desired.

271. The bits used in the brace are many in number and adapted for widely different purposes. Some of the forms assumed by the bit are shown in the accompanying illustration, in which it has been sought to give the general character of bits rather than a representation absolutely correct in its proportions as to length and breadth. Fig. 80 shows the most common form of bit, often called a centre bit, probably on account of the prolongation of its axis or central line into a long sharp point. Bits of this form are made of all sizes, to cut holes from ⅜in. to 1½in. in diameter. The point is thrust into the wood in the centre of the piece

Bits for brace.

Fig. 83

Fig. 84

Fig. 85

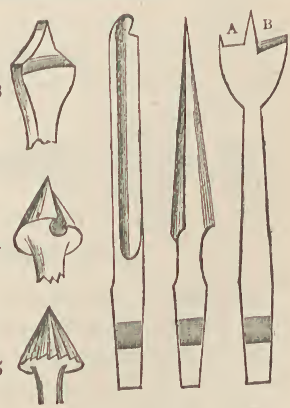


Fig. 82. Fig. 81. Fig. 80
VARIOUS FORMS OF BITS.

that is to be taken out and the tool caused to revolve rapidly by turning the crank of the brace ; the sharp edge A cuts away the wood as the tool enters, and the edge B, which extends from the central spike to the outer part of the bit, scoops it out, so that if its continuity could be preserved without fracture, it would come away in the form of a long spiral ribbon. Fig. 81 is the form of bit used for boring a taper hole similar to the funnel-shaped hole made by the taper augur. Fig. 82 shows a shell bit something like a plain gimlet, with a broad scoop-like edge at the end, instead of a screw for cutting long deep holes. Fig. 83 is a bit of solid form, used as a drill or counter-sinker for metal. Figs. 84 and 85 are counter-sinkers for wood, used when it is desired to let in the head of a screw flush with or below the surface of the wood. Fig. 85 is technically called a rose-bit : it consists of a conical head of steel deeply grooved with ridges running from the edge of the broadest part to the point, and may be used for cutting metal as well as wood, in such operations as deepening the holes in a hinge for the reception of the heads of the screws, and anything similar to this. It has been

Prices of bits.

said that bits cost about 5d. each, or about 12s. 6d. the set of thirty-six bits. This may be taken as the general average price ; but the smaller ones, if bought separately, may cost somewhat less and the larger ones somewhat more. Black bits are rather cheaper than bright bits, and as they are not so liable to rust as the bright bits, they are perhaps preferable for the amateur.

272. The bits that have just been brought under the reader's consideration are what may be termed, for distinction's sake, simple or

Clarke's Patent Expansive Bit.

single bits. There is, however, another bit, which may be made to do the work of a dozen simple bits, especially of the form shown in fig. 80 in the foregoing illustration. This is Clarke's Patent Expansive Bit, an American invention,

FIG. 86. CLARKE'S PATENT EXPANSIVE BIT.

shown in fig. 86. One of these bits, by shifting the position of the trans verse edge by which the wood is hollowed out, may be made to cut holes of any diameter, from ½in. to 1½in., or from ⅞in. to 3in. They are, as may be imagined, expensive. The bit whose expansive power extends to 1½in. costs 7s. 6d., and the larger one, which cuts holes up to 3in., costs 10s. 10d. They are useful tools when it is desired

to have much available power in a little compass, and they have a certain advantage in enabling the operator to cut holes of diameters *between* those of each pair in the series of simple bits; but for the amateur we are inclined to think that the simple bits will be the more serviceable.

273. Before leaving this part of our subject, mention must be made of another kind of American bit—Douglas's Cast Steel Bits. The peculiar form of these bits, which resembles in some degree the screw-auger and which probably found their origin in that tool or were suggested by it, is shown in fig. 87. The

Douglas's Cast Steel Bits.

Fig. 87. douglas's cast steel bit.

diameter and price of single bits of this kind are as follows:

Diameter in inches ...	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
Price each	1/3	1/1	1/1	1/2	1/2	1/3	1/5	1/7	1/9	1/11	2/1	2/3	2/6	2/10	3/6	3/10

They are sold in sets comprising one bit of each diameter, from ¼ in. to 1 in., at 23s. per set. The advantage of this kind of bit appears to lie partly in the screw form of shank, which allows the wood to work up and out, as in the case of the twisted gimlet, and partly in the symmetrical form of the cutter, which operates on both sides alike; whereas in the common form of this kind of bit the wood is cut away by the action of a projecting edge on one side, and then scooped out by a cutter acting transversely on the other side.

274. The next variety of tools that come under consideration includes all those which may be denominated *holding or grasping tools.* They may be classed in two divisions: first, the simple tools of this description used for pulling out nails, holding, cutting, and bending wire, etc., which comprise pincers, all kinds of pliers, spanners, and wrenches; and, secondly, the more complex holding tools, such as the vice, which assumes various forms, and is distinguished according to its construction, as the hand-vice, bench-vice, etc. While pincers and pliers are holding tools in the sense that they supply mechanical contrivances for clutching the head of a nail, and withdrawing it from the wood in which it is embedded, which operation could not be effected without the appliance of considerable force, they may be regarded as holding tools which enable the operator to impart motion to some other body. The vice, on the contrary, is a holding tool in the sense that by tightening its jaws

Holding or grasping tools.

another body is held so that it cannot move, or be moved, while the operator is cutting it with a file, or otherwise fashioning it into some desired form.

275. The ordinary forms of pincers and pliers are shown in the annexed illustration. Fig. 88 represents the common pincers, which are made of iron, and in various sizes, ranging from 4in. to 12in. in length. These are sold at different prices, according to size and quality. Common pincers may be bought at prices ranging from 7d. to 1s.; but the best kind that are made are sold at the rate of 3d. per inch, or from 1s. to 2s. 6d. each. The amateur artisan should provide himself with a small and large pair of pincers of the best kind. The most convenient sizes are 5in. and 8in. Common pincers are apt to get indented along the margin of the jaws, by which their grasping power is greatly impaired.

Pincers and pliers.

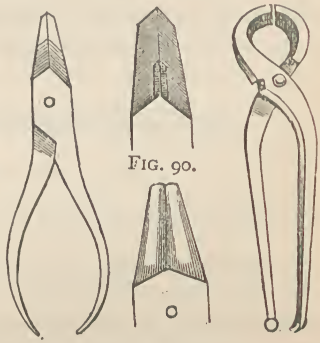


FIG. 90.

FIG. 89. FIG. 91. FIG. 88.
PINCERS AND PLIERS.

Flat pliers.

In fig. 89 a pair of flat pliers, of the ordinary kind, is represented. The construction of these and the pincers is so apparent from the illustration, that any detailed description is unnecessary. When it is desired to use either, the handles are drawn apart which causes the jaws to extend as well, but in a less degree, because the length of the jaws from the pivot on which the two parts of the tool work is less than the length of the extremities of the shanks or handles from the same pivot. In fig. 90 is shown the head of a pair of cutting nippers. In these the holding or flat part of the jaws extends about half-way down from the extremities, where they are cut away on either side so as to form a sharp wedge-shaped blade with which, from its peculiar construction, wire may be cut in two without injury to the edges of the blades. These are useful at all times, but more especially in wire-working. Fig. 91 represents the head of what are termed round-nosed pliers. The jaws of these instead of being flattened for gripping small nails, wire, etc., are rounded from base to tip, so as to present the appearance of small cones with the tops taken off. These are used for turning the end of a piece of wire so as to form a loop by which it can be attached to a larger wire, etc., if necessary. By making the noses in the form of cones, that is, tapering from base to top, loops of various

Cutting nippers.

Round-nosed pliers.

sizes can be more conveniently formed. Good cutting nippers cost from 1s. 6d. to 4s.; but they may be bought of an inferior quality at from 8d. upwards. Pliers, both flat and round-nosed, range from 6d. to 1s. 3d. per pair, inferior quality; or from 1s. to 3s. 6d. per pair, best quality, according to size. There is a smaller kind of pliers, useful to artificial fly makers or in splicing, the jaws of which extend by pressing the handles together. When released the handles resume their original position by means of a spring, and the jaws close, retaining in their grasp any fine substance such as the end of a bit of silk, or wire, or the extremity of a cock's hackle. These are of no use in carpentry except in splicing or in coiling thin wire round a core of wood or metal, but they are mentioned to show that pliers are made which open by bringing the handles closer together, as well as those whose jaws are extended by drawing the handles apart.

Spring pliers, for fly making, etc.

276. Many an amateur artisan will, for cheapness' sake, utilise packing-cases, egg-boxes, tinned-meat and lobster cases, and other boxes, which may be purchased at very low rates from fancy goods warehousemen, drapers, grocers, and oilmen. Much wood that can be made available for a variety of purposes and bought at a merely nominal price, can be got out of such goods as these; but the operator in nine cases out of ten will spoil half the boards in taking the box or case to pieces. Naturally enough he will set to work with hammer and screwdriver, wrenching and forcing bottom from sides, and sides from ends, and when the work is accomplished he will find that half the boards are spoilt, or broken, or cracked part way down their length, and therefore far less useful than they were before he commenced operations. And he has spoilt the handle of his screwdriver, too, by striking it with the hammer, forgetting that wooden handles should be struck with a mallet instead of a hammer, and that a cold chisel would have been far more suitable than a screwdriver.

Utilisation of packing-cases, etc.

Causes damage to tools.

277. There is, however, a capital implement by which the box may be taken to pieces without injury to either nails or wood. This useful tool, shown in fig. 92, is called the "Victor" Nail Puller. The following directions are given for using it: "Grasp the instrument in the manner represented in the cut, taking care to have the left hand as low down as convenient. Place the jaws astride the nail in the wood, with the foot-lever parallel with the grain of the wood, drawing the top of the tool towards you, till they come close up beside the nail; lift the rammer with the right hand, plunging

"Victor" nail pullers.

it down suddenly. This operation embeds the jaws beside the nail, then pull horizontally, which brings the nail out." The price of the "Victor" Nail Puller is 10s.; but the amateur who uses up plenty of packing-cases in his work for rough fencing, sheds, fowl-houses, etc., will soon save the cost in the boards that are not split and damaged past using, as when hammer and screw-driver are used, and in the nails which are not deprived of their heads and can be used again. The nails with which these cases are nailed together are for the most part wire nails, generally known as French nails. They are very tenacious, and well suited for most of the work that the amateur will do. The rapidity with which nails can be withdrawn by means of this nail puller is wonderful. When once the jaws are set about the nail one blow of the rammer sends them into the wood, and one pull of the instrument towards the operator brings out the nail. A slight indentation in the wood, where the head of the nail was, is the only injury that the wood receives, and this is so trifling as to be inappreciable. The ends of the board are not split, and can therefore be worked up again in any way that the operator may desire.

FIG. 92. "VICTOR" NAIL PULLER.

278. The wrench or spanner is chiefly useful for turning the nut on or off the screw end of an iron bolt. The annexed illustration, fig. 93, represents the common wrench or spanner in which the handle forms the screw for moving the jaws apart. In this kind of spanner the upper jaw, or jaw furthest from the handle, is movable, and is propelled upwards or drawn downwards, as may be desired, by turning the handle round one way or the other. They are made in lengths ranging from 6in. to 12in., and the best vary in price from 2s. 9d. to 4s. 10d., according to size. The American screw wrench, shown in fig. 94, differs from the ordinary wrench in having the lower jaw movable instead of the upper, and in having the upper jaw

Wrench or spanner.

FIG. 93.
COMMON WRENCH.

rigidly connected with the wooden handle in which it is set. The lower jaw is moved by means of a screw turned by a small thumb wheel. The prices of these wrenches are as follows : 6in., 3s. ; 8in., 3s. 4d. ; 10in., 4s. ; 12in., 4s. 8d. ; 15in., 8s. They can be procured from Messrs. Churchill and Co., who also sell a useful little tool for the amateur called the "Excelsior" Pocket Wrench —fig. 95—whose jaws will open to the extent of ⅞in , and whose weight is only 4oz. The prices of these little spanners are 1s. 8d., bright finish, and 2s. nickel plated. Of course they cannot be used for any rough kind of work, or for nuts larger than ⅞in. square.

FIG. 94. SCREW WRENCH.

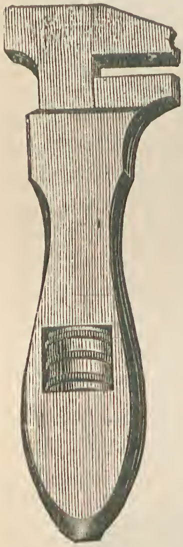


FIG. 95. "EXCELSIOR" POCKET WRENCH.

Vices necessary to amateurs.

279. A vice is indispensable to the amateur, and he should provide himself with both a hand vice which, as its name implies, can be held in one hand, while the file, etc., is applied by the other hand to the object that is held within its jaws, and a bench vice, which can be attached to a carpenter's bench and removed at pleasure. The bench vice will of course hold larger objects and pieces of material than the hand vice, and, as it is fastened to the bench itself, and need not be held in any way, or even steadied by the operator, both hands can be used in filing or in performing any other process to which the bench vice is auxiliary.

Ordinary hand vice.

280. The ordinary form of hand vice is a couple of strong jaws connected at one end by a pivot or rivet, on which they work, and terminating at the other in a broad end, as shown in fig. 96. If the screw were removed, the shanks would be extended and kept apart by the spring which is attached to one of them, and works against the other. The jaws are relaxed or brought together by the screw, which works through the shanks by means of a bar, which works loosely in the head of the screw. Hand vices cost from 1s. to 2s. 6d. each, according to size. Bench vices are similar to hand vices in the general principle of their construction ; but to the

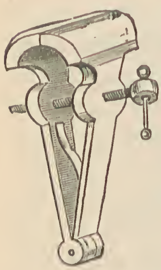


FIG. 96. HAND VICE.

Bench vice.

shank furthest removed from the head of the screw two arms are attached at right angles, or nearly so, to the shank, one of which—the upper one—terminates in a broad, flat plate, which rests on the upper surface of the bench, while through the lower one works a thumb-screw, also capped by a disc, which is screwed up hard and fast against the lower surface of the bench-board, when it is sought to make use of the vice. A common bench vice may be bought for about 2s.; a better kind of vice, with square thread and steel jaws, cost from 4s. to 11s., according to size; while the best black staple vices are sold, according to weight, at 7d. per lb.

Patent vices.

281. The patent vices, of which there are various kinds, are very expensive, and are not required by the amateur. It may, however, be mentioned that a useful saw-grinder's vice, for holding a saw when being set or sharpened, with jaws 9in. long, and jointed near the bench, so that the jaws may be thrown backwards or forwards at pleasure, may be purchased for 6s. The amateur, however, may for a few pence construct a simple contrivance which will answer all the purpose of the saw-filer's vice. For 6s. 6d. an "Improved Hand Vice" may be bought, which is much more handy and convenient to hold than the old-fashioned one. This vice is of metal throughout, the jaws being of forged steel, and the handle of case-hardened malleable iron. The jaws work on pivots passing through the oval, or nearly oval, disc

Improved hand vice.

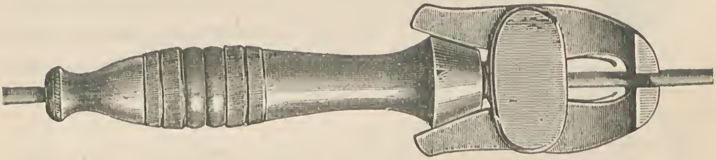


FIG. 97. IMPROVED HAND VICE.

shown in the illustration, and are opened or closed by means of the bevelled top of the handle, which works on a screw attached to the disc. The jaws are relaxed by turning the handle downwards, and closed by turning it upwards. A hole is made through the handle and screw for holding wire, as shown in fig. 97.

Tools of guidance and direction.

282. In good carpentry everything depends on accuracy of measurement of parts, and fitting the parts together at right angles, or at the required angle or bevel. For the attainment of these most necessary requisites *tools of guidance and direction* of various kinds are used, without which it were impossible even for a skilled carpenter or joiner to do his work, and fit the

various pieces together with the nicety that is essential in all operations of this nature. Thus, for setting out a long, straight line in ripping a slip of wood from a board, a *line and reel* is required; and for measurement of any length into parts, or of any required length, breadth, and thickness, the *carpenter's rule* is needful. For cutting off the end of a board at right angles to the edge, or for mortising, etc., the *square* is a *sine qua non*, and for cutting wood at any given angle to the edge, the proper line of direction for the saw must be marked by aid of the *bevel.* For cutting notches in wood, or for cutting or planing down pieces of wood to the same thickness, the necessary guide lines must be marked by a *marking gauge*, while in mortising the *mortise gauge* is used. For joining pieces of wood at right angles, as in making a picture-frame, recourse must be had to the *mitre box;* and for subdividing any given space into smaller spaces, or marking out circles and sweeps of various diameters, the *compasses* must be used. In turning, to make sure of having the diameter of various parts of the work in harmony with the pattern, these diameters must one and all be tried and regulated by the *callipers* as the work goes on. In bringing horizontal bars, shelves, etc., to a true level, the *spirit level* must be used; and in fixing a post in the ground, or a piece of quartering to the wall, the *upright level* with cord and plumb bob. A *straight-edge* is useful for testing the nicety and accuracy with which wood has been planed up, and for other purposes. In bricklaying and fixing stonework of considerable length the A *level* is used. It is requisite to gain some idea of these various appliances, and the manner in which they are used. The mode of handling and using saws, edge tools, and other tools of different descriptions, will be considered in a subsequent chapter.

The line and reel.

283. First of all the line and reel. This appliance costs but a few pence; it is not generally named in price lists. Any large-sized reel will do, provided that it be deep enough to carry some few yards of line or cord, which must be of a non-elastic

FIG. 98. LINE AND REEL, SQUARE, AND BEVEL.

character in order to do its work effectually. To give an example of its use, suppose that A B C D, in fig. 98, is a long rectangular piece of

board that it is desired to saw into two equal pieces. Having ascertained by the rule that the ends A D, B C, are really equal in length, and that the board is of the same gauge or measure across throughout, divide each end into two equal parts in the points E, F. Make a knot and loop in the line, and through the loop pass a fine bradawl, pushing it deeply into the wood precisely at the point E. Do the same at F with another bradawl, and strain the line tightly from one to the other, securing it to the bradawl at F with a knot and loop. Before straining the line, it should have been whitened with chalk, or blackened with charcoal. If the strained line be now lifted as far off the board as possible with the finger and thumb of the right hand, and then, released suddenly, it will strike the board smartly along its length from bradawl to bradawl, leaving a straight white or black mark on the surface from E to F, which will serve as a guide for the saw in cutting it in half. In using the saw amateurs are apt to throw too much pressure either to one side or the other, which causes the saw-cut to go out of the straight line. In sawing planks and boards lengthwise it is as well to repeat the operation with the chalk or charcoal line on the other side, the bradawls being allowed to remain in their places to ensure accuracy of register, and then to look at the under part of the board from time to time to see that the saw-cut is being accurately carried in the right direction.

How to use the line.

284. The carpenter's rule is a well-known instrument consisting of two pieces of boxwood joined at one end by a flat brass joint, and tipped with brass at the other extremity. They are divided into inches, which are again subdivided into 8ths and sometimes 12ths of inches. In the ordinary rule the two slips of boxwood are each 1ft. in length, so that the rule is 2ft. long when extended. This is the best kind of rule for an amateur to have. They

Carpenter's rule.

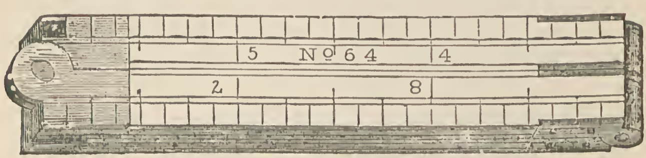


FIG. 99. FOURFOLD NARROW RULE.

may be had at all prices from 6d. to 1s. 6d.; or, if with brass slide rules, from 1s. 10d. each to 2s. 6d. Brass, iron, and steel rules may be had at equally low prices. Messrs. Churchill and Co. supply a handy 1ft. fourfold narrow rule for the pocket (fig. 99), graduated in 8ths and 16ths of inches, and $\frac{5}{8}$in. wide. These rules, if with round

joint middle plates, are sold at 6d. each; if with square joint middle plates, at 7d.; and with arch joint middle plates, as in the accompanying illustration, at 8d. 2 ft. fourfold rules, 1in. wide, are sold at 8d., 10d., and 1s. each, according to the character of the middle plate; and the broad 2ft. rules at 1s. 2d., 1s. 6d., and 2s. each. These are 1⅜in. wide, and are graduated in 8ths, 10ths, and 16ths of inches, and are furnished with draughting scales. A useful 2ft. twofold rule with arch joint, bitted, furnished with Gunter's slide, graduated in 8ths, 10ths, and 16ths of inches, 100ths of a foot, and with drafting and octagonal scales, 1½in. wide, may be had for 2s. 4d. The slide renders this a useful rule to amateurs.

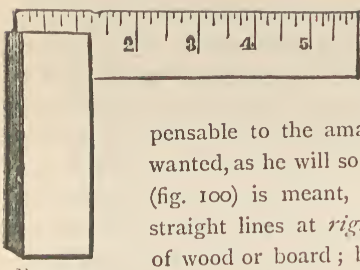


Fig. 100.
The Square.

Square and bevel.

285. The square and the bevel are shown in the accompanying illustrations, which will indicate the general character of these useful tools, which are absolutely indispensable to the amateur, and which will be continally wanted, as he will soon find by experience. The square (fig. 100) is meant, as its name implies, for drawing straight lines at *right angles* to the edge of any piece of wood or board; but the bevel (fig. 101), is intended for drawing straight lines at *any angle* to the edge of a piece of wood; therefore the blade of the square is fixed immovably in the stock or handle, while that of the bevel is movable. The mode of using the square and bevel is shown in the illustration of the manner of using the line and reel in fig. 98, the square being represented on the *left* of the figure, and the bevel on the right. The stock in either case is applied to the edge of the board, so that the blade rests flatly upon it, having the outer or inner edge just touching the point at which the line is to be drawn on the upper surface of the board. Good ordinary squares in rosewood, with a blade 6 inches long, cost from 1s. 9d. to 2s. 6d.; and bevels of the same quality, with blade 7½ inches long, about the same price. The length of the blade of the square ranges from 3 inches to 12 inches in length, and the blades of the bevels from 7½ inches to 10 inches. In price, squares range from 1s. 4d. to 4s. 3d., according to size and the wood of which the stock is made; the bevels from 1s. 9d. to 5s. The Patent Hardened Try Square and Flush T

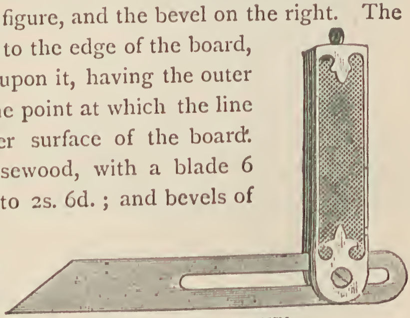


Fig. 101. The Bevel.

Bevel supplied by Messrs. Churchill and Co. are of superior description. The square has an iron stock, nicely finished; the blade is of hardened cast steel with parallel edges. Every angle is accurate, and it is a perfect tool, though somewhat expensive, costing according to length of blades : 3 inch, 6s. 9d. ; 4½ inch, 8s. ; 6 inch, 9s. ; and 8 inch, 11s. each. The handle of the bevel is also made of iron, and the blade of fine steel spring tempered, with perfectly parallel edges. The blade is held in any position desired, by moving the lever which slightly projects at the bottom. They cost according to length of blade : 8 inch, 5s. 6d. ; and 10 inch, 6s. 3d. each.

Hardened try square and flush T bevel.

286. In speaking of squares, a brief mention and description of Ames's Patent Universal Square may not be uninteresting to amateurs who are desirous of knowing something about adaptations of the leading principles of ordinary tools, as well as about these tools themselves. Fig. 102 gives an accurate representation of this square, and explains its application as a centre square, as which alone it is invaluable to every mechanic. Put the instrument over the circle ; as, for example, the end of a bolt or shaft with the arms B A, E A, resting against the circumference, in which position one edge of the rule, A D, will cross the centre. Mark a straight line in this position ; apply the instrument again to another part of the circumference and mark another line crossing the first. The point where the two lines cross each other is the centre of the circle. The whole is the work of a moment. The tongue, D A, fastened, as it is, into the triangular frame B A E, cannot be moved or knocked from its place—in this respect constituting a great improvement over the carpenter's try square, T square, and mitre in common use. The instruments are made of the best material, neatly finished, and

Ames's Patent Universal Square.

FIG. 102. FIG. 103.

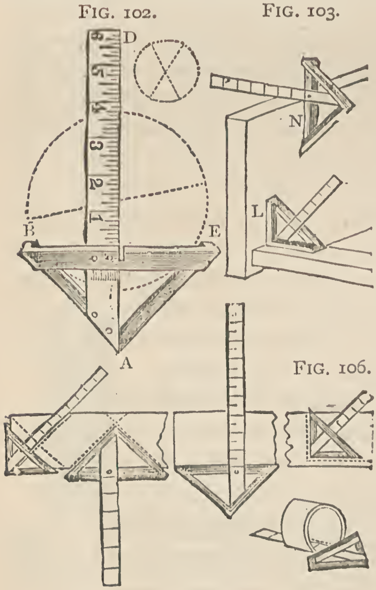


FIG. 106.

FIG. 104. FIG. 105. FIG. 107.
AMES'S PATENT UNIVERSAL SQUARE.

perfectly true. Fig. 103 explains the application of the instrument as a carpenter's try square as at N, and as an outside square as at L. In fig. 104 its use is shown as a substitute for the mitre, while in fig. 105 it is shown as a T square and graduated rule; and in figs. 106 and 107 as an outside square for drawing, and a T square for machinists. The square combines, in short, in the most convenient form, *five* different instruments: namely, try square, T square, mitre, graduated rule, and—what is entirely new—the centre square, for finding the centre of a circle. It may be fairly said, indeed, that no mechanic's or amateur's list of tools can well be complete without a universal square. The prices are according to length of blade: 4 inch, 11s. 3d.; 6 inch, 13s. 6d.: 8 inch, 18s.; 10 inch, 25s.; and 12 inch, 31s. 6d. It is the graduation, doubtless, of the steel blade or rule of the Patent Universal Square that renders this useful instrument so costly—for costly it is, and beyond dispute out of the reach of many amateurs for this very reason. The clearness, however, of the illustrations of the various purposes to which the square may be put, combined with the description given above, will enable many to construct a rough instrument of the kind for their own use which, in all probability, will do the work that is wanted quite as well, although it may lack the good appearance and nicety of finish of the genuine article.

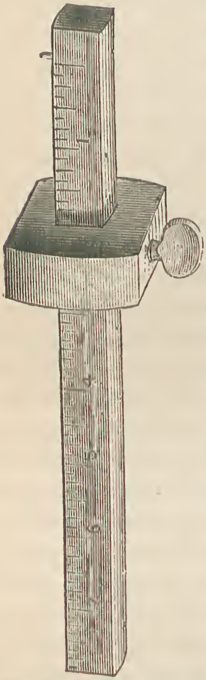


FIG. 108. MARKING GAUGE.

287. The next kind of tool that demands our attention is the gauge in its two varieties, known as the gauge pure and simple, or marking gauge, as it is generally called, and the mortise gauge. Fig. 108 represents the marking gauge. This consists of a beech wood bar with a block or head of the same

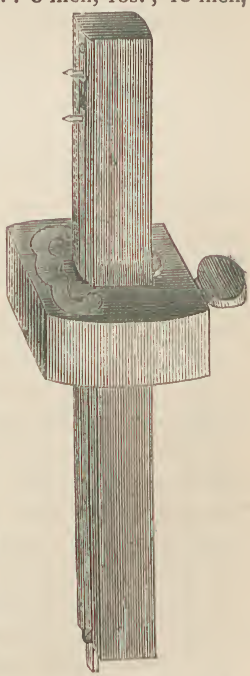


FIG. 109. MORTISE GAUGE.

material, which slides up and down the bar, and is retained in any desired position by the thumbscrew. A steel point is inserted close to the upper end, and when it is desired to mark a line on a piece of wood parallel to the edge, the head is moved down the bar until the requisite distance between the steel point and the upper surface of the head is obtained. The head is then held against the edge of the wood, with the steel point pressing on the wood, and when the gauge is moved up and down a line is marked on the wood by the steel point. Ordinary marking gauges may be bought from 7d. to 1s. The marking gauge figured in the illustration has the advantage of being graduated down one side of the bar in inches. Gauges of this description are sold by Messrs. Churchill and Co., at prices ranging from 3d. to 8d. each.

Marking gauge.

The mortise gauge, shown in fig. 109 is similar in general principle to the marking gauge; but it has in addition a slide working in a groove in the bottom side of the bar, by which means two lines parallel to each other and to the edge of the wood can be marked at one operation, the steel point in the groove and the head of the gauge being set at the required distances from the fixed steel point. English made mortise gauges of the better kind range from 2s. 6d. to 7s. 6d., according to the material of which they are made, and the degree of finish bestowed on them. The American mortise gauges range in price from 2s. 8d. to 3s. 4d. An excellent double gauge, unpolished beech wood, marking and mortise combined, may be bought of Messrs. Churchill and Co., for 1s. 4d., and one of a superior quality for 3s. These combination gauges are commended to the attention of amateur artisans.

Mortise gauge.

288. A level, as the name implies, is an instrument for ascertaining if one cross piece of wood from one post to another is fairly and actually horizontal, and inclines neither to one side or the other; or if the joists of a floor are in a perfectly horizontal position, so that when the flooring boards are nailed to them the floor of the room may be perfectly level. It is also used for ascertaining that stones or courses of brickwork are properly laid; and that posts, framing, and all work which consists of uprights or vertical pieces of any kind are fixed perpendicularly—that is to say, at right angles to the plane of the horizon. Conversely, a true horizontal line is at right angles to a line that is truly vertical or perpendicular. To determine whether or not carpenters' and bricklayers' work is level or upright, different kinds of levels are used, and these must now be described.

Levels: their principle.

289. Fig. 110 will explain the general principles of the *spirit level*, an instrument of great utility which every amateur artisan should possess. The engraving represents the section of an ordinary spirit level taken lengthwise. The body of the level is generally made of some hard wood, as oak, walnut, rosewood, etc., and it need scarcely be said that the heavier the wood the better it is for the purpose. In the upper part of the wood a groove, A B, is cut,

Spirit level.

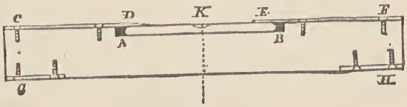


FIG. 110. THE SPIRIT LEVEL.

just deep enough and long enough to receive a round tube of glass, *nearly* filled with spirit, and hermetically sealed at both ends to prevent the escape of the fluid that is thus imprisoned within it. When the tube has been properly placed in the groove cut for its reception, the upper surface should be just flush with the upper surface of the wood. A thin brass plate with a long narrow hole in the centre is then placed over the glass and wood as at C D E F, in which D E represents the slit in section. To protect the bottom of the level, plates of brass are sometimes attached to it at the ends, as shown at G and H. It has been said that the tube is *nearly* filled with spirit. The remaining space is occupied by air, and this air, which appears in the tube in the form of a bubble, being lighter than the spirit will always rise to that part of the tube which happens to be highest. When the tube is in a horizontal position as there is not sufficient air to extend along its entire length, the air takes the form of an elongated bubble, which shifts from end to end as each is raised and lowered in turn. When the level is in a perfectly horizontal position the bubble is precisely in the centre of the tube as at K; when the end H of the level is raised it will run upwards towards E; and when G is raised it will run in a contrary direction towards D In practice, therefore, if, when the level is laid on a shelf or any other piece of wood that is placed in a horizontal position, the bubble is found to be in the middle of the tube, the shelf is exactly in the position it ought to be, and truly level; but if it be a little too high at either end the shifting of the bubble towards that end will show that the end in question requires lowering a little, or that the other end must be raised, as may be most convenient, until the bubble by taking up its position in the middle of the tube, indicates that the wood is now perfectly level.

Method of applying level to long lengths.

290. It may happen, however, that the wood itself is level, but that it does not appear to be so, from the indications given by the bubble

in the spirit level. The reader will naturally ask, How can this be? and to his query we must reply that for the level to do its duty with accuracy, it is necessary that the *surface* of the wood itself be perfectly level; that is to say, *accurately and truly planed up*. Suppose, for example, that the surface of the wood was not level but irregular, going first down and then up, as in the line A B C D E in fig. 111. The diagram is exaggerated it is true, as it appears here, but let the reader imagine such depressions to occur in a length of 6 feet, instead of a length of 3⅝ inches, and the notion of exaggeration which is conveyed by the diagram will disappear. The piece of wood, whose upper surface is represented by

Requirements for accurate levelling.

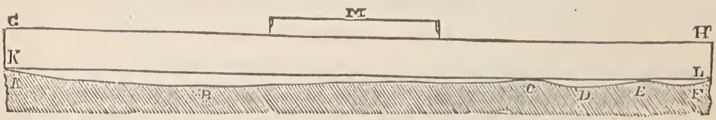


FIG. 111. USE OF THE STRAIGHT-EDGE.

the irregular line A B C D E F, is actually in a truly horizontal or level position; but if the level be laid on the part B C, the bubble will shift towards C, and the amateur following the dictate of the level will drop the end F until the bubble goes to the centre, and thus throw his work out of the level instead of bringing it level as he thinks he is doing. Again, if the level had been laid on A B, the bubble would have gone towards A, and he would then have lowered the end A. Or suppose that after lowering the end F he had laid the level on A B, he would have found the level telling him to raise the end F, while a moment before it had been directing him to lower it, and being puzzled by the discrepancy he would begin to lose faith altogether in the accuracy and utility of his level.

291. Now all this is simply because the spirit-level is, comparatively speaking, short, being seldom more than 10 inches in length, and generally less than this, and it will only indicate the true level with accuracy *for its own length*, unless the wood has been planed up so that its surface is smooth and level from end to end; or if the wood be unplaned and rough from the saw, if it be level from end to end. To get over any difficulty of the kind that has been set forth above, the amateur must provide himself with a straight-edge; or—as this term is generally applied to a piece of wood or metal, of which one side only is perfectly true and straight, to test the accuracy of the surface of a joint that the carpenter is making, as in a panel, or the

Level positively acurate for own length only.

Use of straight-edge in levelling.

surface of metal that a smith is filing—with what we may call a double straight-edge; that is to say, a piece of wood about five or six feet in length, four inches wide, and ⅞ inch or one inch thick, such as is shown above the irregular surface A B C D E F in fig. 111. In this double straight-edge, which must be made for the amateur by a good joiner, the sides G H, K L, must be perfectly true, level, and parallel to each other, and, that this desirable end may be completely attained, must be shot by a trying or joiner plane. When such a piece of wood as this is laid along such a surface as A B C D E F, and the spirit level is placed about its centre, as at M, a level about five or six feet in length, according as the length of the piece of wood may be, is formed, which shows that the points A, C, F, of the surface of the wood below it are in a horizontal line, and that the wood itself is in a horizontal position, although its *surface* is by no means level. The utility of the straight-edge, in testing the accuracy with which the planing up of any surface has been performed, must now be obvious to all and nothing more need be said about it.

292. The piece of wood that has just been described as a double straight-edge may be further utilised in another way, namely as an upright level, or, to speak more correctly, as a plumb level. **Plumb level.** First of all it must be stated that, by the force of gravity which tends to draw everything in a direction towards the earth's centre, if a weight be attached to one end of a string and the other be held in the hand or fastened round a nail driven into a wall, the string, when the weight at the lower end has ceased to oscillate and is at rest, will be vertical, or perpendicular. Now, if a hole, shaped something like a pear when cut in half longitudinally, be made near one end of the straight-edge as at A, and three nicks be made with a saw at the other end as at B in fig. 112, the wood will serve the purpose of a plumb level. It is requisite that the middle nick be cut in a straight line running exactly midway down the board from end to end, and that the pear-shaped hole be symmetrically cut on either side of this central straight line. The next thing to be done is to take a piece of string or cord, not too thick, and thread one end of it through a hole made for the purpose in a leaden or brass plummet, commonly called a plumb-bob. **Plumb-bob.** A leaden plum-bob will cost from 6d. to 1s. according to size and weight, and a brass one from 2s. upwards. The other end of the string must be

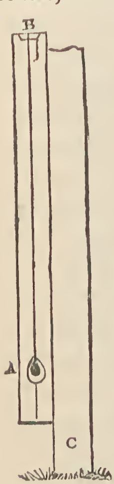


FIG. 112.
PLUMB LEVEL.

twisted into the saw cuts at B, care being taken that it is first put through the central cut so that the line may hang fairly down the centre of the board. The string must also be adjusted in such a manner that the plumb-bob may hang freely just within the central hole at A, the top of the plumb-bob being from ⅛in. to ¼in. below the upper end of the hole. Now suppose the amateur artisan is fixing a post in the earth as at C, or fixing an upright against a wall. If, when the plumb level is applied to the post, as shown in the illustration, the plumb-bob, when at rest, is in such a position that the string covers the centre line marked down the board from top to bottom, the post or upright is perpendicular. If, however, it inclines too much to the right or the left the weight of the plumb-bob will carry the string out of the central line in the direction to which the post inclines, and it must be slightly shifted until the cord and plumb-bob assume the proper position. In the case of a post let into the earth, it is necessary to try it with the level on two contiguous faces to ensure accuracy of position with regard to its being perpendicular.

Use of plumb level in fixing post, etc.

293. The A level, as it is called from its resemblance to the letter A is merely an adaptation of the plumb level for determining the accuracy with which level courses of bricks are laid, or stonework of any kind, as stone paving, etc. In the centre of the long straight-edge, A B in fig 113, which is generally from five feet to eight feet in length, a plumb level, C D, is set perpendicular or at right angles to the straight edge A B. Strength and rigidity is given to the whole structure by means of braces, E, F, which impart to the level the appearance from which it derives its name. When the straight edge A B is placed on the top of the last course of bricks that has been added to a brick wall in course of building, the bricklayer can judge of the correctness of his work by the position of the plumb line, which acts in the same manner as it does in the simple plumb level. In a similar manner the mason can judge whether or not the stones he has placed in position, or the pavement that he has laid, is level; or the carpenter of the joists that he has laid from wall to wall, or any wall plate that he is about to fix, whether or not all is true and square and level.

The A level, or Bricklayer's level.

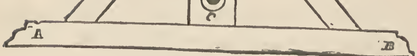


FIG. 113. THE A LEVEL.

294. Some cheap and beautifully finished spirit levels are imported from America and sold by Messrs. Churchill and Co. Of these the cheapest are the Davis Iron Pocket Level. These are of various sizes, according to which the price also varys. The smallest, 3in. long, costs 10d.; and the others, 5in., and 8in. are 1s. 3d. and 3s. 6d. respectively. In fig. 114 is represented one of these iron pocket levels, with an attachment at the side furnished with

American spirit levels.

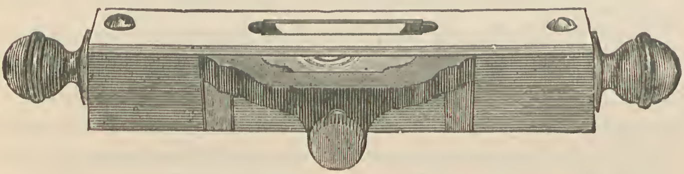


FIG. 114. DAVIS IRON POCKET LEVEL.

a screw with round head and milled edges, by which the level can be attached to a square or straight-edge. The Stanley levels are all good of their kind. A handy pocket level, six inches long, with a bulk of three inches, made of iron and surmounted by a brass cap, is sold for 2s. Other more elaborate levels, made in wood and furnished with two spirit glasses—one to indicate the true level, and another to show the true perpendicular—are more costly than those which have just been described. The cheapest level of of this kind, not adjustable, costs from 3s. 4d. to 4s., according to length, which ranges from 24in. to 30in. The average price of the adjustable plumb and level in mahogany is 5s. These range from 26in. to 30in. in length, as do the better kinds of the adjustable level, which, when furnished with side views and brass-bound corners, cost from 6s. to 9s. each, taking the average price which is lessened slightly or increased according to the length of the level. In the adjustable plumb and level, the spirit glass or bubble tube in the level is set in a metallic case, which is attached to the brass top plate above it—at one end by a substantial hinge, and at the opposite end by an adjusting screw which passes down through a flange on the metallic case. Between this flange and the top plate above is inserted a stiff spiral spring, and by driving or slacking the adjusting screw, should occasion require, the spirit glass can be instantly adjusted to a position parallel with the base of the level. The spirit glass in the plumb is likewise set in a metallic case attached to the brass top plate at its outer end. By the use of the adjusting screw the plumb glass can be as readily adjusted to a right angle with

Stanley levels.

Adjustable plumb and level.

the base of the level if occasion requires, and by the same method as adopted for the level glass. The principle of the plumb level is shown in fig. 115. A hole with funnel-shaped sides is made through the level as at A. Then at B a vertical hole is made in which a tube filled with spirit is inserted. Part of this tube, where it breaks the circumference of the round hole made through the level, is shown at C. When the spirit level is standing on a perfectly horizontal surface and the eye is directed towards any post or upright through the hole A, if the edge of the plumb level is coincident with the edge of the post or other object, the post is vertical or upright.

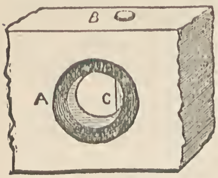


FIG. 115. PRINCIPLE OF PLUMB LEVEL.

Prices of common levels.

English made spirit levels are sold at various prices from 8d. to 10s. They vary in length from 4in. to 14in. The following may be taken as being fair average prices for common levels according to length :

	4in.	6in.	8in.	10in.	12in.	14in.
Walnut with brass top plate...	/8	1/-	1/4	1/8	2/-	2/3
ditto with brass top plate and tipped bottom ...	—	1/8	1/10	2/3	2/10	3/-

Mitre box.

295. If the amateur artisan is inclined to turn his attention to the manufacture of picture frames, it is necessary that he should provide himself with a *mitre box.* He will also find this box useful for cutting mouldings or any piece of wood which it is necessary to cut across at an exact angle of 45 degrees.

Construction, etc. of mitre box or block.

296. The price of a mitre box, or mitre block as it is often called, ranges from 2s. 6d. to 5s., but any joiner will make one that will serve the amateur's purpose quite as well as one that is purchased from the tool maker. The annexed illustration will show the principle on which the mitre box is made. In fig. 116 the block itself is shown in perspective. A piece of wood rectangular in form, from 18in. to 22in. long, and measuring about 4in. by 5in. in section, is rebated so as to form a couple of steps, as shown in the diagram.

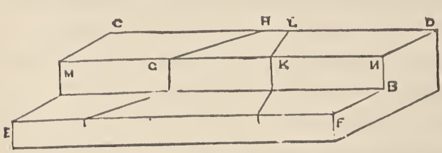


FIG. 116. MITRE BOX.

The rebate may be taken out to the extent of half the width and half the thickness. Saw cuts, H G, K L, are then made *through* the upper part, or upper step, of the block, and to the distance of ¼in. into the lower block, and these cuts are made so as to be exactly at an angle of 45° to the edges C D, E F, of the block ; the angles G H C

and K L D being each an angle of 45°. This may be seen more clearly in fig. 117, which represents a plan of the block, or the appearance it would present to the eye of a beholder when looking directly down upon it. The letters in fig. 116 are repeated in fig. 117. Now if a piece of wood or moulding be laid on the lower step, A E F B, and held tightly against the vertical part A M N B,

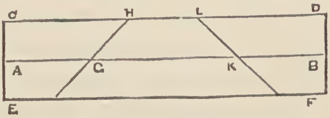


FIG. 117. PLAN OF MITRE BOX.

the extremity may be cut off by passing a saw into the guide line G H, or L K, as may be necessary, and sawing through the moulding. The saw cuts should be wide enough to admit a tenon saw with ease. The extremities of each of the four pieces that form a picture frame must be cut at opposite angles of 45° by aid of the mitre box, that they may join at right angles at the four corners.

Improved American mitre box.

297. The Americans have brought into use an improved mitre box (fig. 118), which is sold by Messrs. Churchill and Co. It is somewhat expensive, costing 28s. by itself, or 40s. when a 20in. Disston's back-saw is supplied with it. The length of this mitre box—which is better calculated for picture-frame makers and others, who would use it much more than amateurs,

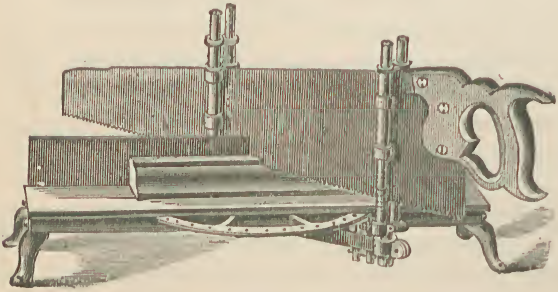


FIG. 118. IMPROVED AMERICAN MITRE BOX.

who would but seldom use it—is 20 inches. The frame is made of a single casting, and is subject to no change of position ; being finished accurately at first, it must always remain true. The slot in the back of the frame through which the saw passes is only ⅛ inch wide, thereby avoiding any liability to push short pieces of work through the slot when the saw is in motion. This mitre box can be used with a back or tenon saw, or a panel saw equally well If a back saw is used, both links which connect the rollers or guides are left in the upper grooves, and the back of the saw is passed through the under links.

If a panel saw or small hand saw is used, the link which connects the rollers on the back spindle is changed to the lower groove, and then the blade of the saw will be stiffly supported by both sets of rollers and may be made to serve as well as a back saw. By slightly raising or lowering the spindles, when necessary, the leaden rolls at the bottom may be adjusted to stop the saw at the proper depth ; and by the aid of a set screw the spindles on which the guides revolve may be turned sufficiently to make the rollers bear firmly on the sides of a saw-blade of any thickness.

298. From the mitre box we must pass on to compasses and callipers which, as it has been already said, are used, the one for dividing out spaces and marking out circular-work ; and the other for the comparison of the gauge or diameter of parts of a piece of work that is being turned on the lathe with the pattern or working drawing.

Compasses and Callipers.

299. The compasses used by carpenters and joiners are made of iron, the legs being strong and solid, and the points somewhat blunt. The larger compasses are sometimes filled with an arc, which is fastened to one leg, as at A, and passes through a slot in the other leg at B. A thumb-screw passes through the side of the leg at B, and when it is desired to retain the distance between the points of the legs for any purpose, the thumbscrew is screwed tightly against the arc. It is difficult, if not impossible, to alter the position of the legs until the pressure exacted by the thumbscrew is relaxed. The compasses, with arc, are shown in fig. 119, while in fig. 120 a pair of callipers is represented. These are nothing more than bow-legged compasses ; the legs being bowed, or bent, so that the points may be more readily applied to the diameter of any work in the lathe. Like the compasses, they are made in different sizes. Compasses range in price from 6d. to 10s., and callipers from 1s. to 18s., according to make, size, and quality. A useful pair of rule-joint compasses may be bought for 8d., and a pair of wing-compasses, or compasses fitted with arc, from 1s. 6d. A serviceable pair of spring-callipers may be bought for 1s. 6d., and a pair of good wing-callipers for 2s.

Compasses with arc.

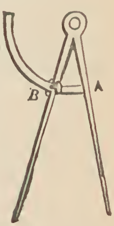


FIG. 119. COMPASSES.

Callipers.

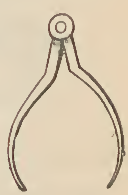


FIG. 120. CALLIPERS.

300. Among the many useful inventions bearing on carpentry, joinery, and engineering, that have been introduced of late years by

Americans, are calliper rules and squares. They are, however, too costly for general use. A steel calliper rule, 3 inches long, with a slide that can be drawn out 2½ inches, graduated to 12ths, 24ths, 48ths, 8ths, 14ths, and 28ths of an inch on one side; and 16ths, 32nds, 64ths, 20ths, 50ths, and 100ths on the other; and on the slide to 32nds and 64ths of an inch, remarkable for accuracy and durability, may be had of Messrs. Churchill and Co. for 18s. The same firm supplies calliper squares with or without adjusting screw. These are graduated according to English measurement in inches and parts of inches on one side, and in accordance with the metric system on the other. These squares, without adjusting screw, cost, if 2 inches long, 16s., and if 4 inches long, 21s.; with adjusting screw, if 2 inches long, 19s., and if 4 inches, 25s.

Calliper Rules and Squares.

Stanley's Ivory Calliper Rules are handy pocket companions. The twofold 6 inch rule, with square joint in German silver, ⅞ inch wide, and graduated in 8ths, 10ths, and 16ths of an inch is useful and inexpensive, costing 3s. 2d. The calliper rule represented in fig. 121, will show the character of these rules, and how they are used—the diameter, or gauge of any work being measured between the *inside* of the foot of the slide and the end of the rule, and indicated by the graduations on the slide. This rule, which is made of boxwood, with arch-joint and edge-plates in brass, is fourfold; it is 12 inches long, and 1 inch wide, and graduated in 8ths, 10ths, 12ths, and 16ths of an inch. The price is only 2s.

Stanley's Ivory Calliper Rules.

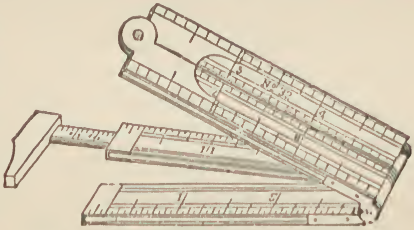


FIG. 121. GRADUATED CALLIPER RULE.

301. There are many miscellaneous tools and appliances used in Carpentry and Joinery which are not subject to any classification as those are which have been already described. Among these we may include the screwdriver, the nail-punch, the reamer or rymer, the scriber, the cramp, the glue-pot, and the oil-can. Sand-paper, on paper or cloth, with finely-powdered glass or emery-powder on one side of it, must also be noticed. There is another appliance called the bench holdfast, which is used to hold wood firmly down on the carpenter's bench when necessary; but as it will be more convenient to speak of this in immediate connection with the carpenter's bench, no further mention of it will be made here.

Miscellaneous Tools used in Carpentry.

302. The *screwdriver* bears some slight resemblance to the chisel, although it is used for a very different purpose. It is an iron blade set in a wooden handle, with the end ground so as to form a long bevel on either side. The edge is blunt, but should be fine enough to enter the nick across the head of a screw with ease. In the annexed illustration, fig. 22 shows the ordinary form of the screwdriver, and fig. 123 the manner in which the blade is let into the handle, the ferule being nicked, or slotted about ⅛ inch in depth. The heel of the blade just above the tang is tightly fixed in the slot, and additional firmness is thus imparted to the tool, and the blade is prevented from turning in the handle, as bradawls will often turn, much to the vexation of the operator. Screwdrivers vary in length from 3in. to 12in., and may be bought at prices ranging according to size, from 6d. to 3s. The size of the tool used must always be suited to the work in hand, that is to say, to the size of the screw to be driven or withdrawn. The larger the screw the greater the friction and resistance of the wood that must be overcome in driving the screw in or taking it out. The amateur artisan is therefore recommended to provide himself with three screwdrivers—one small, one of medium size, and the other large, say 3 inch, 6 inch, and 10 inch in length of blade. These may be bought for 8d., 1s., and 2s., respectively, of sufficiently good quality for all ordinary purposes. Fig 124 shows the round-bladed screwdrivers, a form which is more generally used by the engineer and smith. Round-bladed screwdrivers are dearer than the ordinary sort, but three useful ones of the sizes above named may be bought for 10d., 1s. 3d., and 2s. 3d., respectively. Fig. 125 shows the American Cast Steel Screwdriver, an excellent tool of this description supplied by Messrs. Churchill and Co. The blades are made from the best quality of cast steel, and are tempered with great care. They are ground down to a correct temper, and pointed at the end by special machinery, thus procuring perfect uniformity in size, form, and strength, while the peculiar shape of the point gives it unequalled firmness in the screw-head when in use. The shanks of the blades are properly slotted to receive a patent metallic fastening, which secures them permanently in the handles. The handles are of the most approved pattern, the brass ferules being of the thimble form,

The Screw-driver.

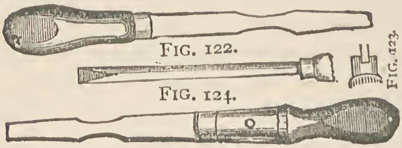


FIG. 125. FORMS OF SCREWDRIVERS.

Round-bladed Screwdriver.

American Cast Steel Screwdriver.

extra heavy and closely fitted. The prices and sizes in which this useful kind of screwdriver is made are :—1½ inches, 4d. ; 2 inches, 6d. ; 3 inches, 8d. ; 4 inches, 10d. ; 5 inches, 1s. ; 6 inches, 1s. 2d. ; 7 inches, 1s. 4d. ; 8 inches, 1s. 7d. ; and 10 inches, 2s.

Nail-punch or Brad-punch.

303. The *nail-punch*, or *brad-punch*, is a short piece of steel or case-hardened iron, blunt at one end, and tapering to a square or round point at the other end, according as the punch itself is square or round. Brad-punches are sold at 2d. each, the larger flooring punches at 3d. each. They are used to drive the head of a brad or nail below the surface of the wood, when the hole that is left above the head can be filled up with putty, and all traces of the nail be hidden. When a nail is to be punched in, it should not be struck directly with the hammer after the head is about $\frac{1}{16}$ of an inch above the surface of the wood, lest the wood be bruised and dented with the blow of the hammer. In nailing down flooring the floor-brad is driven below the surface, because, when the boards begin to wear, the head, which is harder and will not wear away at the same rate, projects above the floor, and is inconvenient, if not absolutely dangerous.

Reamer or Rymer.

304. The *reamer*, or *rymer* as it is sometimes called, though the former is the proper mode of spelling the word, is a steel tool set in a handle and used for the purpose of enlarging a hole in a piece of metal ; as, for example, in a hinge whose screw-holes are not quite large enough to admit the screws. It is made in different forms, but most commonly in the shape of a long, stiletto-like, four-sided blade, thick at the haft, and tapering to a fine point, which is useful for marking lines on wood, leather, zinc, or any other material. A good reamer may be bought at from 6d. to 1s. The tool just described is often called a *scriber* because its point is useful for scribing (Latin *scribo*, I write) or marking lines on wood, etc. A small rat-tail file may be used by the amateur as a reamer.

Cramp or Clamp.

305. The *cramp*, or *clamp*, is a contrivance that is used for bringing boards close together and retaining them in position until they are fixed in their place by pegs or nails. It is also used by cabinet-makers for bringing glued work together and keeping the parts or pieces in close juxtaposition until the glue has set. The principle on which the cramp works may be seen from fig. 126. A is a long bar, along which works a movable head B, which may be fixed in position at any part of the bar by screws, as shown in the engraving, one of which works into a groove in the side facing the beholder; another screw, which does not appear, working in a similar groove on the other side. The head C is also movable, but only to

the extent permitted by the screw D that is attached to it. When the head B has been fixed so as to allow the work to slip in easily between it and the head C, the latter is brought tightly against it by the action of the screw D, and remains fast fixed between the jaws till the screw is relaxed. The amateur artisan will find a clamp indispensable in chair-mending and other similar operations. The prices of the American clamps sold by Messrs. Churchill and Co., of which the improved kind with malleable iron head and jaws and wrought screw is shown in the above illustration, are as follows :—

FIG. 126. THE CLAMP.

CLAMPS WITH WOODEN HEADS.

	s.	d.		s.	d.
2ft. inside jaws	3	9	4ft. inside jaws	4	7
3ft. ,, ,,	4	2	5ft. ,, ,,	5	0

CLAMPS WITH IRON HEADS.

	s.	d.		s.	d.
2ft. inside jaws	8	4	4ft. inside jaws	9	0
3ft. ,, ,,	8	8	5ft. ,, ,,	9	4

The iron-heads, jaws, and screw, may be had without the wooden bar for 6s. 9d.

Joiner's Cramp.

306. The joiner's cramp differs from the above in construction, although the general principle is precisely the same. The bar is of iron, and the heads are so constructed as to be slipped over the bar and work freely along it ; the bar is pierced at regular distances with holes, into which an iron peg is inserted to fix the head that is nearest the end over which the heads are passed. At the other end of the bar is an iron ring, through which works a deep-threaded screw, turned by a bar through the head in the same manner as a vice-screw. When the other head has been fixed by the peg that is inserted behind it, the boards, or any other pieces of wood that may have been placed between the heads can be brought tightly together by the action of the screw, as in the cabinet-maker's clamp. Joiners' cramps range in length from 3 feet to 6 feet, and cost from 25s. to 37s. 6d., according to size.

307. In fig. 127 is shown Hammer's Adjustable Clamp, a handy article for amateurs for small work, made of malleable iron, and of great strength. By turning the bolt one quarter to the left, it can be moved its full length out or in; when turning to the right it operates like any other screw. Hand-screws are also useful for clamping. These consist of two parallel jaws or blocks of wood, which are brought together or apart, as may be desired, by two wooden screws, running transversely through the bars and working in opposite directions. These useful articles are sold by Messrs. Churchill and Co., at the following prices, according to diameter and length of screws, and length and size of jaws, which are also given:

Hammer's Adjustable Clamp.

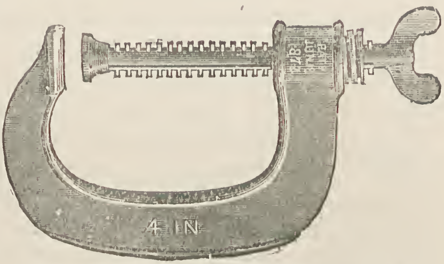


Fig. 127. Hammer's adjustable clamp.

Diam. of screws.	Length of screws.	Length of jaws.	Size of jaws.	Each.	Diam. of screws.	Length of screws.	Length of jaws.	Size of jaws.	Each.
In.	In.	In.	In.	s. d.	In.	In.	In.	In.	s. d.
$\frac{1}{2}$	10	8	$1\frac{1}{4} \times 1\frac{1}{4}$	0 9	1	18	16	$2\frac{3}{8} \times 2\frac{3}{8}$	2 6
$\frac{5}{8}$	10	$8\frac{1}{2}$	$1\frac{3}{8} \times 1\frac{3}{8}$	0 10	$1\frac{1}{8}$	20	18	$2\frac{5}{8} \times 2\frac{5}{8}$	2 10
$\frac{3}{4}$	12	10	$1\frac{5}{8} \times 1\frac{5}{8}$	1 1	$1\frac{1}{4}$	24	20	$2\frac{7}{8} \times 2\frac{7}{8}$	3 6
$\frac{7}{8}$	16	14	2×2	1 7					

308. For bringing the glued edges of boards tightly together, a simple cramp may be quickly improvised in the following manner. Suppose that A, B, C, in fig. 128, represent portions of these boards, glued lengthwise along their edges: D E is a long piece of wood, on each end of which is screwed a block of wood, bevelled inside, as shown at F and G; the boards when glued are laid in the hollow between the projecting cheeks E, F, and wedge-shaped pieces of wood H, K, are driven in between the cheeks and the outer edges of the board. Of course the further the wedges are

Simple cramp that can be made by amateurs.

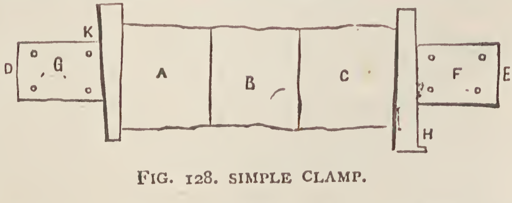


Fig. 128. Simple clamp.

driven in, the closer will the edges of the boards be brought together, and the more firmly united will they be.

309. Mention must be made of the *carpenter's pencil*, which the amateur artisan will be constantly wanting to mark lines on wood, in accordance with the guidance given him by rule, square, and bevel. Marks should be made on wood with a pencil in preference to a scriber, as the latter must of necessity scratch the surface of the wood while the pencil does not. Pencils for carpenters and joiners, etc., are square, round, and oval in form, and of these three shapes the oval is certainly the best. They are sold at 1d. each ; but as pencils, like most small tools and sometimes large ones, are often mislaid, or rather, hastily laid down (and so hastily, very frequently, that the workman cannot remember where he has placed them), it will be as well for the amateur to provide himself with a dozen, which may be bought for 8d. or 10½d., according to quality. It is almost needless to say that the best are the cheapest. The disappearance of a pencil or tool when mislaid, and the time and trouble that are involved in looking for it, often suggest the idea that these things have an unpleasant knack of hiding themselves.

Carpenter's pencil.

Pencil often mislaid.

310. The *glue-pot* is an essential in every house, whether the householder or occupier turns his attention to household carpentry or not. So many little odd jobs can be done by its aid, that if nothing more than a hammer and screw-driver be kept, a glue-pot should be purchased to form a *trio*. For example, a piece of veneer may come off a looking-glass frame, or any piece of furniture, and may be mislaid or lost before a carpenter happens to be at work in the house, putting these and similar little matters in order. Now, if the piece of veneer is lost it will be made a costly business—that is to say, costly in proportion to the actual damage—to replace it, and if the missing piece is not replaced the appearance of the piece of furniture is spoiled, and its value considerably deteriorated. But, if a glue-pot is at hand, the damage may be instantly repaired, and if the mending is carefully done, as it ought to be, the piece of furniture is little the worse for the mishap.

Glue-pot.

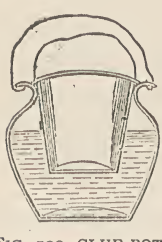


FIG. 129. GLUE-POT.

311. The glue-pot is shown in section, or, as it were, cut in half, in fig. 129. It is a pot within a pot, the outer and larger one being of iron, and the smaller one of copper or iron, as the case may be. The glue is broken up small, and placed in the smaller pot, which fits into the larger pot, the rim of the former resting

Construction of glue-pot.

on the rim of the latter. Water is placed in the larger pot, sufficient to nearly fill it when the smaller pot is put in. The pot is placed on or close to the fire, and as soon as the water boils the glue begins to melt, until it is reduced to a semi-fluid condition.

312. The following is a good recipe for making, or rather melting, glue. It is taken from Spon's "Workshop Receipts:" "Break the glue into small pieces, and soak from twelve to twenty-four hours in cold water; put the glue in the glue-pot, fill the outer vessel with water, and apply heat. For ordinary purposes it should run freely, and be of the consistency of thin treacle. The hotter glue is, the more force it will exert in keeping the two parts glued together; in all large and long joints the glue should be applied immediately after boiling. Glue loses much of its strength by being often melted; that glue, therefore, which is newly made is much preferable to that which has been used. When done with, add some of the boiling water from the outer vessel to the glue, so as to make it too thin for immediate use. Put it away till wanted again, and by the time the water in the outer vessel is boiled the glue in the inner is ready melted and the proper thickness for use. Powdered chalk, brickdust, or saw-dust added to glue, will make it hold with more than ordinary firmness."

Recipe for making glue.

313. In the above recipe everything is said that an amateur need know about glue, and how it should be used. A small brush used by painters, and usually called a sash tool, should be used for applying the glue. It is better not to keep it in the glue in the pot; but when it has been used, to soak it in boiling water, and then put it away in some safe place until it is again wanted for use. A serviceable glue-pot may be bought at from 1s. to 2s. 6d.; good glue is from 9d. to 1s. per pound, and a glue-brush from 2½d. to 3d.

Brush for applying glue.

314. The amateur artisan will require an oil-can as well as a glue-pot, for he will often have occasion to use oil for one purpose or another. It is indispensable to him when he is sharpening any edge-tool on the hone or oil-stone, and it is useful for oiling locks, and other similar purposes. In former days a phial bottle half filled with oil, with the quill end of a fine feather passed through the cork, so that the feather end may always be kept in the oil, and having a loop of string round its neck so that it may be hung up in the artisan's shop ready for use, was the simple appliance by means of which the carpenter oiled his whetstone for sharpening his tools, and made locks, bolts, etc., work noiselessly and easily; but this has been of late years superseded by the oil-can.

Oil-can.

Forms of oil can.

315. The oil-can in its usual form very much resembles a funnel turned upside down, but instead of being open at the broad end it is furnished with a flexible bottom, which can be pressed inwards. When pressed, the diminution of the space inside—the bulk of air that may be within the can remaining the same—causes a drop of oil to escape from the nozzle, after which the bottom returns outward with a short, sharp click. The nozzle is of brass, and is perforated lengthwise, the hole being just large enough to admit of the passage of a bristle, or very fine wire. It screws into a brass cap, which forms part of the body of the can, and through which oil is poured when it is necessary to fill it. The price of an ordinary oil-can ranges from 6d. to 1s., according to size. A better form of the oil-can is to be found in the improved "Goodenough" Oiler, sold by Messrs. Churchill and Co. This can is represented in fig. 130. It is compact, strong, and tight, and from its shape is suitable for carrying in the pocket. The body, or reservoir, is made of fine block-tin, flat like a watch, with flexible sides, which give it a double spring. The spout is of heavy brass to insure strength : it has a tight joint, and is tinned inside to prevent corrosion of oil. The brass cap is packed with hard leather, which presses against the outlet of the spout as the cap is screwed down, and effectually prevents leakage. Among other good points that this oil-can possesses, not the least is that, even if laid down with the nut off, it will not leak, unless pressed or jarred. The price of this handy and useful little oiler is 8½d.

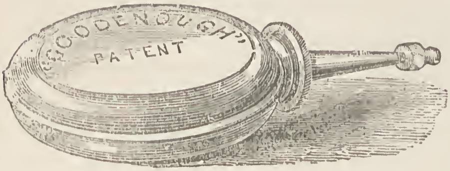


FIG. 130. GOODENOUGH OIL-CAN.

"Good-enough" oiler.

Sand paper or glass-paper.

316. Although it does not come within the category of tools, yet as a useful aid to carpentry and joinery, especially to the latter, and to cabinet-making, *sand-paper* must be mentioned here. It is chiefly used for imparting a smooth surface to wood cut against the grain, as in circular work, or in rubbing down the surface of joinery and cabinet work, and giving to it smoothness and softness. It is also used for other purposes, such as rubbing down coatings of paint, etc. For giving smoothness to wood, especially to rounded work, the keen edge of a piece of broken glass will be found useful. Sand-paper—or glass-paper as it is indifferently, but more correctly, called, as it is made of powdered glass strewn on the surface of coarse paper, which has been washed over with thin glue, or some other sub-

stance to which the powdered glass will adhere—is made in three different qualities, distinguishable by different numbers or letters according to the makers; but which may be described here as fine, medium, and coarse. It is sold at ½d. per sheet, or 10d. per quire of twenty-four sheets; but glass-paper of the best quality, for cabinet work, costs 1s. per quire.

317. We must now turn our attention to *tools in combination*, that is to say, to tools which are so contrived as to answer more purposes than one, like the general run of ordinary tools. The chief of these is the combination saw, which has been described in section 233, and which may be used as a measure, a rule, or a straight-edge, and a square as well as a saw. Such tools as these are more suitable for amateurs' use than for carpenters and joiners, inasmuch as they save the purchase of the tools whose work they do as well as their own special duty. Our counsel to the amateur, however, is to avail himself of these tools, if he have a fancy for them, but on no account to refrain from purchasing the single and separate tools which are combined in the tool of many uses. Many of these tools have been produced of late years; but we merely intend to speak of such of them here as may be more than usually useful to the amateur house-carpenter. Those which most commend themselves to notice are *Boardman's Combination Wrench* and the *Pad* or *Patent Tool Handle and Tools.* To these may be added a useful little article for indoor use, called the *Tack-hammer, Setter, and Puller* combined. All these articles are supplied by Messrs. Churchill and Co.

Tools in Combination.

318. Boardman's Combination Wrench is represented in fig. 131,

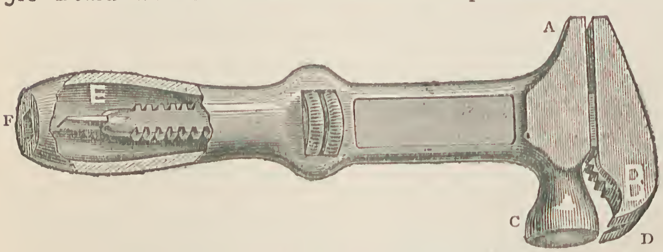


FIG. 131. BOARDMAN'S COMBINATION WRENCH.

in which part of the handle is removed to show the internal arrangements. This combination, indeed, comprises *six* useful tools, neatly and compactly arranged in a convenient form for practical use. These tools are—a screw wrench or nut wrench (A), pipe wrench (B), hammer (C), nail claw (D), screwdriver (E), and bit handle or socket wrench (F). The sizes in which

Boardman's Combination Wrench.

this instrument is made and its prices, according to size, are as follows:

Length.	Bright.	Nickel Plated.	Length.	Bright.	Nickel Plated.
4½ inches	3s. 2d.	4s. 2d.	8 inches	6s. 2d.	7s. 6d.
6 "	4s. 2d.	5s. 3d.	10 "	8s. 4d.	10s. od.

319. The pads or patent tool-handles with tools contained within, and varying in number from 12 to 20, are very useful. In fig. 132 is shown a strong and serviceable iron handle, and the kind of tools that are stored within it, to be fitted, each and any as may be required, in the opening made for their reception at the end of the handle. The tools include bradawls and gimlets of various sizes, a scriber, countersinker or drill, screw-driver, and reamer. Sometimes the rose or round-headed countersinker is

Pads or patent tool-handles with tools.

FIG. 132. PAD, OR PATENT TOOL HANDLE.

added. The price of the iron handle with 12 tools is 2s.; of one slightly larger with 20 tools, or of an apple-tree handle with the same number of tools, 3s. The price of a Turkey boxwood handle with 20 tools is 4s.; and that of a handle also of boxwood, but fitted with an adjustable chuck, and containing 20 steel tools, 5s. These combination tools are very handy for odd jobs about the house, and save looking up the ordinary tools, for which they are excellent substitutes.

320. While speaking of *tool-handles*, it may be well to say that if the amateur has the misfortune to break or otherwise injure his saw or plane handle—we are supposing that he uses an ordinary wooden plane,—saw handles in beech can be bought of Messrs. Churchill and Co. for 5d. and 6d. each, and in cherry for 7d. Jack-plane handles in beech cost 2d. each, and handles for trying or jointer planes, 3d. each. Tool handles for bradawls, with steel screw and nut with iron wrench, into which a new bradawl or awl of different size can be introduced at pleasure, cost 4d. each. Polished apple handles for firmer chisels are 2d. each, or 2s. per dozen; larger handles assorted, 2s. 6d. per dozen.

Handles for various tools.

321. To return from this digression to the last combination tool that it is intended to mention here—the tack-hammer, setter, and puller combined (fig. 133). The following are the directions for the use of the tool which costs but 10d.: for setting tacks when putting down carpets, when it is too close to the wall or skirting-board to hold the tack with the fingers, with one hand spring the jaw open, and with the other hand place in the tack as represented in the cut, and with one good blow, stick, or partly drive the tack. This operation requires a very little practice, care being taken to take the hammer off quickly, as the force of the blow throws the jaw open, to release the tack, and if taken off with the rebound it will not have time to grasp it again. For driving, use in the same way as any hammer. To draw a tack, place the jaws astride the tack with the foot lever just touching the floor, with the handle of the tool straight up. Press down sufficiently to get a good hold of the tack, and then pull horizontally. This operation brings out the tack perfectly straight. It must be remembered that this tool is meant for pulling out tacks only, and not for pulling out nails.

Tack-hammer, setter, and puller.

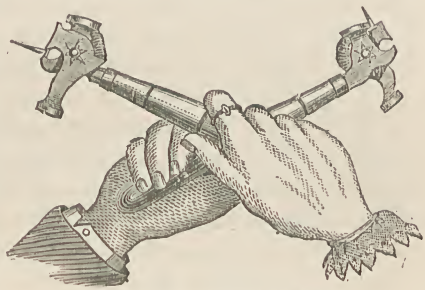


FIG. 133. TACK HAMMER.

322. The various tools that are used in cutting and fashioning wood into different forms, or at least such of them as are really necessary to the amateur, in the ordinary operations of Carpentry and Joinery have now been described; but before quitting this part of our subject, it will be necessary to speak briefly of the articles used for fastening pieces of wood together other than glue. These articles are nails of different kinds, screws of different sizes, and pegs of wood.

Articles for fastening pieces of wood together.

323. Let us take the pegs first. It is possible that most men know that the planks that form the outer skin or covering of wooden ships are fastened to the oaken ribs by bolts of copper or tree-nails, which, as the name implies, are long pieces of wood, roughly rounded and driven with an iron bound mallet into holes which have been bored through planks and into ribs by an auger. The use of tree-nails on a smaller scale is desirable in fastening the component pieces of all framed work, such as

Wooden pegs and tree-nails.

doors, windows, etc., and uprights and horizontal pieces mortised and tenoned into one another. Nails and screws must never be used in sashes and doors, though mortise and tenon work in rough framing may be secured by nails, which are generally driven in aslant. This mode of driving in nails is termed "skew-nailing." In fig. 134, in which the end of the upright A is mortised into the horizontal piece B, the fastening is made by means of pegs, holes being first made at C and D, through the horizontal timber B, and the tenon of the upright A, into which pegs are driven. The pegs should be made of red deal. It is obvious that if it be required to make any alteration in consequence of the work not being perfectly square, or if it is desired to take it to pieces at any time, the pegs can be bored out with a gimlet or bit and brace, and the tenon drawn out of the mortise without injury. When there is no likelihood of this, and it is desired to make the work as firm and secure as possible, the end of the tenon is split crosswise with a chisel as at E and F, and two small wedges are driven in. This has the effect of pressing the ends of the tenon so tightly against the mortise-hole in which the tenon is placed, that it is a matter of the greatest difficulty to withdraw it, if it can be done at all. The rails of doors and horizontal pieces of sash frames are tightly fixed in the uprights in this manner. Wherever it is practicable in carpentry and joinery, the amateur artisan is recommended to put his work together with wooden pegs.

Pegging mortise and tenon.

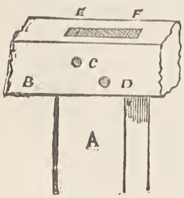


FIG. 134.
MORTISE & TENON.

Wedges in tenon.

324. There are many kinds of nails in general use, distinguished by various names and by variety of form. The sorts to which the attention of the amateur must be directed, as these will be the nails which he will chiefly use at various times, are: brads, cut nails, clasp nails, rose nails, clout nails, lath nails, tacks, and French nails. There are others, but as it is doubtful if he will ever require them, it is next to useless to mention them. It must be remembered that we are now speaking of nails used in carpentry and joinery. Fancy nails and studs used in ornamental work and upholstery, such as nailing a slip of leather or leather cloth to the edge of a book-shelf, or a piece of fringe to a mantel-board, will be mentioned in connection with work of this kind.

Nails: their varieties.

325. *Brads* are, for the most part, long thin nails, tapering slightly from the head to the point, which is blunt, and having a slight projection on one side of the head only. The general form is shown at A

in fig. 135, and the amateur must bear in mind that in these illustrations of nails it is only intended to show him the different types, as it were, of these nails, and to help him to distinguish them one from the other when he sees them before him. Of brads there are many different kinds: there is the *joiners' cut brad*, used in joinery and ordinary cabinet making, varying in size from ½ inch to 2 inches; and the *flooring brad*, a coarse heavy brad about 2½ inches long, used in nailing down flooring to the joists on which it rests. These brads are made in various weights per thousand, and are distinguished by the number of pounds that a thousand weigh: thus there are 10lbs., 12lbs., 14lbs. floor brads, and so on. The brad used in fine cabinet making is somewhat lighter and slighter than the joiners' cut brad, but in other respects they are similar. There is another kind of brad without any head, sometimes used by glaziers to fix panes of glass before the putty is applied; and a third variety used by pattern makers, etc., in which the head projects slightly beyond the body of the nail on all sides. Being light, thin, and slightly tapering, brads do not split the wood into which they are driven.

Brads

Joiners' cut brads.

Floor brads.

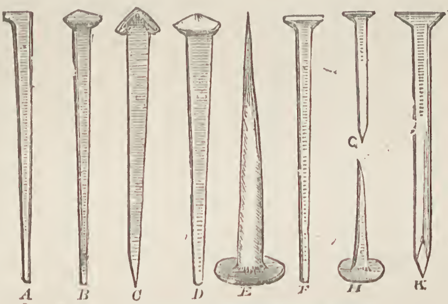


FIG 135. NAILS OF VARIOUS KINDS.

326. The *cut nail* is a coarsely made common kind of nail, with a rough head projecting slightly on two opposite sides, as shown at B. It may be bought in lengths varying from ¾ inch to 6 inches in length, and even more, at 2d. per lb., though 2½d. or 3d. is sometimes charged by the retail dealer, especially for the smaller sizes. The writer has been asked as much as 5d. per pound for cut nails, and in consequence has left the shop without buying, a course which his readers are recommended to follow, as there is no difficulty whatever in finding men who are content with a legitimate profit, instead of coveting at least 100 per cent. more than they are entitled to. The cut nail is useful for all kinds of ordinary work in which the nail is to be driven straight into the wood, but it must be remembered that they will not clench, or, in other words, that the end or point cannot be turned by the hammer and driven into the wood so as to prevent withdrawal.

Cut nails.

327. It is different, however, with the *clasp nail* figured at C, which, being a wrought nail and made of malleable iron, can be turned and clenched. There are strong clasp nails and fine clasp nails; the latter, which weigh from 2lbs. to 6lbs. per thousand, being used in joinery, while the heavier and longer kinds are more suitable for carpentry. The nail is so called because through the peculiar barb-like form of the head it clasps the fibre of the wood into which it is driven as soon as it meets it, and carries it down in its grasp leaving a somewhat large and ragged hole. This kind of nail can be easily driven down level with the surface without the aid of a punch by reason of the conical form of its head, but if it is desired to bury the head the punch must be used.

Clasp nails.

328. The *rose nail* is a wrought nail with a round head, projecting upwards in the centre, in the form shown at D. The body of the nail is broad, and less in depth or thickness than in width. Sometimes they are made with broad flat points, and sometimes with sharp points; these nails may be clenched. They are made in two varieties, namely, fine rose and strong rose. The best nails of this description appear to be those made by J. J. CORDES AND Co., of *Dos Works*, *Newport*, *Monmouthshire*. The flat-pointed fine rose nails made by this firm range from 1in. to 3½in. in length, the strong rose, also flat pointed, from 1¼in. to 4in. The best rose with sharp points range in length from 1½in. to 3in., as do the best Canada and fine clasp, both sharp-pointed varieties, made by this firm. These nails are sometimes called "Ewbank's nails," from the late Mr. Ewbank, formerly a member of the firm who introduced them into Australia about 1838, where they are still much used and highly valued.

Rose nails.

329. The *clout nail* is shown at E. It has a broad flat head, and a round shank or body terminating in a sharp point. Like most of the nails already described, they are distinguished as fine clouts and strong clouts. Their peculiar form renders them well adapted for nailing iron-work or sheet iron to wood, as the broad head keeps the metal in close proximity to the wood, and cannot break through it as a nail with a smaller head would. Iron nails must on no account be used for nailing zinc to wood-work, as the galvanic action set up by the contact of the two metals, especially when wetted by rain, dew, etc., will soon destroy the zinc all round the head of the nail.

Clout nails.

Iron nails, unfit for nailing zinc.

330. At F the form of the lath nail is shown, used for nailing laths to quartering for partitions of lath and plaster. The thin shank easily

penetrates the lath, and if the lath splits when the nail is driven through it, the two parts are held down to the quartering by the projecting head of the nail. It is not likely that the amateur will do much, if anything, with lath nails; but as it is possible, though far from probable, that he may wish to try his hand at repairing a damaged partition or ceiling, the proper nails to be used are pointed out here.

Lath nails.

331. At G and H are shown the difference between the ordinary *iron* or *tinned tack* (H) and the *French tack* (G), which is merely a small variety of *French nail.* The common tack is coarse and clumsy in make, and is never used in carpentry, except to nail some textile fabric such as canvas, hessian, or the material—a fine kind of canvas—used for the sides of meat-safes, etc., to a framework of wood. The distinguishing qualities of the French tack and the French nail, which is shown at K, are a round head, flat at the top or upper surface and conical below, until the body of the nail is reached. The body or shank is of uniform thickness throughout, except at the extremity, where it is fashioned into a point. Just below the head the body of the nail is ridged or grooved transversely on all sides, thus giving the nail additional power of holding to the wood. French nails are generally round, but there is a square variety, sometimes seen in wooden cases and boxes from abroad. They vary in length from ⅜in. to 4in., and are sold at prices ranging from 6d. per pound for the smallest sorts to 2½d. per pound for the largest, the price being less per pound in proportion as the nails get larger and consequently fewer to the pound.

Iron tacks, and French tacks and nails.

332. The amateur will readily understand that it is far more profitable for him to buy nails and screws in large quantities, if he uses a great many in the course of the year. The following is a resumé of the prices of nails per pound per thousand, or per dozen, as specified:

Prices of nails.

Fine Wire Brads...	per.	lb.	from	6½d.	to	8d.	Rose Head Wroght.	per.	lb.	from	4d.	to	1s.
Joiners' Fne Ct. do.	,,	1000	,,	1½d.	,,	8d.	Clout Fine Wroght.	,,	,,	,,	6d.	,,	10d.
Floor Brads	,,	lb.	,,	2d.	,,	—	Lath Nails, Best Cut	,,	,,	,,	2½d.	,,	—
,, ,, ...	,,	cwt.	,,	11/6	,,	—	Tacks, Cut Common	,,	1000	,,	1½d.	,,	5d.
Clasp Nails Fne Ct.	,,	lb.	,,	2d.	,,	—	French Tacks ...	,,	lb.	,,	5d.	,,	8d.
,, ,, ...	,,	cwt.	,,	12/0	,,	—	,, Wire Nails	,,	,,	,,	2½d.	,,	6d.
Rose Head Cut ...	,,	lb.	,,	2d.	,,	—	FancyBrass-hd. Nls.	,,	doz.	,,	2d.	,,	6d.

333. The form of the screw is well-known. The principle on which it is constructed is exhibited in the annexed illustration, and it will be sufficient to give a drawing of one screw only, as the differences in varieties of the screw from the original type can be easily described. At A in fig. 136 the screw is shown before

Screws: their forms.

it is cut, when it is in the form of a conical-headed, blunt-pointed nail, with a shaft of very nearly the same width from top to bottom, but tapering slightly as it approaches the extremity. At B the screw is shown after a spiral thread has been cut in it from the extremity to about two-thirds of its length in an upward direction. A nick is then sawn or filed across the top to receive the end of the screwdriver and the screw is ready for use.

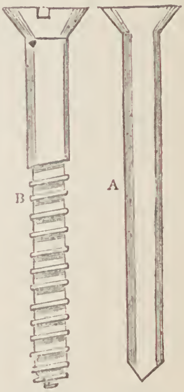


Fig. 136. screw.

334. The principle of the screw, as it has been said, is precisely the same in all. In the wooden screw a deep V shaped groove taken out instead of a broad flat groove which leaves merely a spiral thread winding up the shaft of the screw ; and this form is adopted for the smith's screw used in fastening together the plates and pieces of a stove or kitchen range. This form is shown in fig. 137. Screws are made in all sizes from ⅛in. to 9in. long, and each size is made in various thicknesses to suit different kinds of work and different purposes. Considering, then, the range in length and number of thicknesses in each size it is manifest that there are several score of different sizes from which the purchaser must make his selection according to circumstances. Screws vary in prices from ½d. per dozen ⅛in. in length, to 1s. 9d. per dozen 9in. in length, or by the gross from 3½d. to 19s.

Principle of the screw.


Fig. 137. thread of screw.

Prices of screws.

335. Round-headed screws are made for fastening the plates of bolts and rim locks to doors. The under part of the head in these has the form of a square shoulder which, when the screw is driven home, fits flat against the bolt plate or lock, as the case may be. The head rises from the flat shoulder in a semicircular form, and a deep nick is cut into the rounded head to receive the screwdriver. As there is little bearing for the screwdriver, these screws should be turned in with a strong bradawl or very narrow screwdriver, for when a wide one is used the nick of the screw is apt to get damaged and broken away. Brass screws are made for fastening brass plates to metal. The screws used for fastening handles of doors to the bar, or spindle by which the catch of the lock is turned, are headless, the nick being cut into the blunt end or top of the screw. Sometimes, when the screw is very long and thin, it tapers much more from head to point than in fig. 136.

Round-headed screws.

Brass screws.

336. When using screws care should be taken to bore a hole with a bradawl, if the wood be soft enough, for the entrance of the screw, and to guide its passage into the wood. The diameter of the bradawl used should be somewhat less than the diameter of the screw. A larger bradawl may be used to enlarge the hole at the entrance so as to diminish the friction of the wood against the screw, and *vice versâ*. That a screw may be easily withdrawn, if requisite, the amateur artisan should keep a small tin box filled with grease or tallow by him, into which the end and part of the shank should be plunged before the screw is inserted. Carpenters and joiners have a very bad trick of putting screws into their mouth, or between the lips, and keeping them there while they are screwing them in one by one. This makes the screw rusty, and difficult to withdraw. Therefore, 1. *Never, on any account whatever, put a screw that is about to be used into the mouth.* 2. *Always grease the end of a screw before it is put into the wood, etc.* It may be observed that in driving a screw into wood the screwdriver is always turned inwards towards the left, while in drawing it out it is turned outwards towards the right.

Holes for reception of screws.

Greasing screws before driving.

337. Bolts and nuts are of various forms and sizes; they are distinguished by the form of the head and neck. The principle on which they are made is the same in all cases, being an iron cylinder, of uniform diameter from top to bottom, having a head either flat or rounded, rising from a flat shoulder or surface, placed transversely to the axis of the bolt, and touching the wood or other material against which it is brought to bear at every point. At the end remote from the head a V shaped or bevelled thread is cut, the angle at which the thread is inclined being very small. The screw end enters a nut or square block of metal, with a hole in the centre, also threaded to receive the screw of the bolt. This kind of screw, when cut round the sides of a circular orifice, is technically called a "female screw." In fig. 138 a very common form of bolt is represented, with a round neck, and a rounded or semi-circular head. The same kind of head is sometimes fitted to a square neck, and sometimes the head is square or hexagonal, or in the form of a circular disc as thick at the edges as in the middle. It is almost unnecessary to add that the nut must be turned or worked up the screw with a small wrench or spanner.

Bolts and nuts.

Female screw.

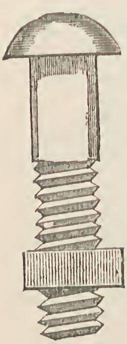


Fig. 138.
BOLT AND NUT.

338. Excellent nails, screws, bolts, etc., of the best quality in all sizes, and at moderate prices, as the writer can testify from experience, can always be obtained from MR. MELHUISH, *Tool Manufacturer and Builders' Ironmonger*, 85 and 87, *Fetter Lane, London, E.C.* Mr. Melhuish also supplies tools of all kinds, hinges, and every description of ironmongery for household purposes that may be needed by the amateur, and American locks, brackets, etc., etc., imported direct from the best American manufacturers of this class of goods.

Where to get good nails, etc.

339. The prices of tools separately have been given under each head; but as many amateur artisans may desire to buy their tools in bulk, in a tool-box fitted to receive them, the following list of tool-chests, with their contents, calculated to suit the requirements and pockets of all, from the man of very limited means to him who can afford to spend as much as he may choose on any particular hobby, will be found useful. In every case the tools are of the best quality, and selected with care, and with a view to the peculiar wants of the amateur. Any tool may be omitted or exchanged for another, when a corresponding reduction will be made in price, when necessary. The chests are made of good and well-seasoned pine or oak, French polished, strongly dove-tailed together, and fitted with brass lock, knobs, and handles of the best quality. The size in each case is exclusive of lids and mouldings. Oak chests are supplied to order by Mr. Melhuish at prices as under, the price for a pine chest in each case being somewhat lower.

Tool-boxes for amateurs.

No. 1. 16 *inches*, £1 4*s*. 6*d*.

Hand-saw	Rule	Chisel	Marking Awls	Square
Hatchet	Pincers	Gouge	Punch	Claw Wrench
Hammer	2 Gimlets	3 Files	Turnscrew	Furniture, etc.
Mallet	2 Bradawls	Oil-stone	Spokeshave	

No. 2. 17 *inches*, £1 12*s*. 6*d*.

Hand-saw	Pincers	1 Gouge	Punch	Claw Wrench
Hatchet	3 Gimlets	3 Files	Turnscrew	Pliers
Hammer	3 Bradawls	Oil-stone	Spokeshave	Compasses
Mallet and Rule	2 Chisels	Marking Awl	Square	Furniture, etc.

No. 3. 18 *inches*, £2 2*s*.

Hand-saw	Pincers	Square	2 Gouges	Lock-saw
Hatchet	Marking Awl	Claw Wrench	3 Files	Plane
Hammer	Punch	3 Gimlets	Oil-stone	Furniture, etc.
Mallet	2 Turnscrews	3 Bradawls	Pliers	
Rule	Spokeshave	3 Chisels	Compasses	

No. 4. 19 *inches*, £2 12*s*. 6*d*.

Hand-saw	Pincers	3 Files	Spokeshave	Lock-saw
Hatchet	4 Gimlets	Oil-stone	Square	Plane
Hammer	4 Bradawls	Marking Awl	Claw Wrench	Marking Gauge
Mallet	4 Chisels	Punch	Pliers	Glue-pot & brush
Rule	2 Gouges	2 Turnscrews	Compasses	Furniture, etc.

No. 5. 20 *inches*, £3 5*s*.

Hand-saw	5 Gimlets	Marking Awl	Pliers	Drawing-knife
Axe	5 Bradawls	Punch	Compasses	Cutting Punch
Hammer	5 Chisels	2 Turnscrews	Lock-saw	Scraper
Mallet	3 Gouges	Spokeshave	Plane	Bevel
Rule	4 Files	Square	Marking Gauge	Furniture, etc.
Pincers	Oil-stone	Claw Wrench	Glue-pot & brush	

No. 6. 21 *inches*, £4.

2 Saws	6 Gimlets	Jack-plane	2 Punches	Compasses
Axe	6 Bradawls	Marking Gauge	3 Turnscrews	Drawing-knife
2 Hammers	6 Chisels	Glue-pot & brush	2 Spokeshaves	Cutting Punch
Mallet	4 Gouges	4 Files	Square	Scraper
Rule	Lock-saw	Oil-stone	Claw Wrench	Bevel
Pincers	Smoothing-plane	Marking Awl	Pliers	Furniture, etc.

No. 7. 22 *inches*, £4 14*s*. 6*d*.

3 Saws	Marking Awl	Claw Wrench	6 Chisels	Glue-pot & brush
Axe	2 Punches	Pliers	4 Gouges	Drawing-knife
2 Hammers	3 Turnscrews	Compasses	Lock Saw	Cutting Punch
Mallet and Rule	Hand-vice	Pincers	Smoothing-lpane	Scraper
4 Files	2 Spokeshaves	6 Gimlets	Jack do.	Bevel
Oil-stone	Square	6 Bradawls	2 Gauges	Furniture, etc.

No. 8. 23 *inches*, £5 10*s*.

3 Saws and Axe	6 Chisels	3 Turnscrews	2 Pliers	Glue-pot & brush
2 Hammers	4 Gouges	Bed Key	Compasses	Drawing-knife
Mallet and Rule	4 Files	Hand-vice	Lock-saw	Cutting Punch
Pincers	Oil-stone	2 Spokeshaves	Smoothing-plane	Scraper & Bevel
6 Gimlets	Marking Awl	Square	Jack do.	Chalk Line Reel
6 Bradawls	3 Punches	Claw Wrench	3 Gauges	Furniture, etc.

No. 9. 24 *inches*, £6 12*s*. 6*d*., *contains in addition to the tools named in No.* 8—

1 File	2 Mortise Chisels	1 Coach Wrench

Many of the tools in this and the following sizes are, of course, larger and of better quality than similar tools in the smaller boxes.

No. 10. 25 *inches*, £8, *contains in addition to the tools named in No.* 8—

1 Hammer	2 Chisels	2 Files	1 Coach Wrench	1 Brace
	12 Bits for Brace	2 Mortise Chisels	Cutting Nippers	

No. 11. 26 *inches*, £10, *contains in addition to the tools named in No.* 8—

1 Hammer	3 Bradawls	2 Files	1 Brace	2 Mortise Chisels
3 Gimlets	3 Chisels	1 Coach Wrench	18 Bits for Brace	Cutting Nippers
	Saw Set	Spring Dividers	Bench-vice	

No. 12. 27 *inches*, £12 10*s*., *contains in addition to the tools named in No.* 8—

2 Hammers	2 Gouges	1 Brace	Nipper Pliers	Spring Oil-can
1 Mallet	5 Files	24 Bits for Brace	Hand Shears	3 Socket Chisels
6 Gimlets	1 Turnscrew	Anvil& BeckIron	Spring Dividers	3 Mortise Chisels
6 Bradawls	Square	Saw Set	Coach Wrench	Bench-vice
6 Chisels	Compasses	Cutting Nippers	Chipping Chisels	Turng.-saw&frm.

CHAPTER V.

SHARPENING TOOLS: THE WAYS AND MEANS EMPLOYED.

Cutting Tools must be Sharp—Modes of Sharpening Tools—Itinerant Saw-setter—Amateur should learn to Sharpen Tools—Form of Teeth of Saw—Saws should be kept Greased—How to open Teeth of Saw—The Saw-set: its Action—Hart's "Patent Saw-set"—Useful contrivance for Saw-setting—Vice for holding Saw—Edge-tools should not be trusted to knife-grinders—Grindstones—Useful Grindstones for Amateurs—Directions for grinding Edge Tools—Gouges—Planes and Chisels—Remarks on the Bevel—Grinding Adze or Axe—The Oil-stone: how to use it—Size desirable for Oil-stones—Turkey Stones—Washita Stones—Prices of Oil-stones—Lubricants for Oil-stone—Position of Tool—Guides: why undesirable—Position of arm, hand, etc.—Sharpening Tools by immersion in Acids—Remarks on this process—Artificial Grindstones—To remove Rust from Tools—To extract Rust from Steel—Preventives against Rust—To prevent Tools from Rusting—Varnish to prevent Rust.

Cutting tools must be sharp.

340. To do any kind of work in Carpentry and Joinery with blunted tools in a creditable and workman-like manner is simply impossible, and it is because in nine cases out of ten that the amateur neglects to sharpen his saws and edge tools when they require it, that his work is so often done with difficulty, and presents anything but a satisfactory appearance when done. The professional carpenter and joiner will frequently stop in his work to put his plane-iron and chisel on the oil-stone—for he is well aware of the importance of having a keen edge to all cutting tools of this description—and he will take care to keep his saws sharpened and fit for use. It is necessary that the amateur artisan should imitate the regular mechanic in this essential duty of keeping his tools in a fit condition to do the work that is required of them; and while he is learning how to manage various operations in carpentry and joinery and how to use his tools, he must also learn how to sharpen them when necessary.

Modes of sharpening tools.

341. Of course all *cutting tools* must be provided with a keen edge, and this is obtained by grinding them to a proper bevel on the grindstone and afterwards rubbing them on the oil-stone. Among *striking tools* the adze and hatchet will require sharpening on the grindstone, and, if necessary, a keener edge may be given by finishing off by rubbing the edge with a slip or small piece

of oil-stone. Among *rasping tools*, all kinds of saws will require sharpening at times, and this must be effected principally by means of the saw-file. If the cutting edge of a bradawl be injured in any way it may be repaired and rendered sharp and even by filing.

342. Let us first inquire into the method of sharpening a saw. It is possible for an amateur to get this done for him by some jobbing carpenter when his saws grow dull, or by any itinerant saw-setter, who goes his regular round at intervals with his bench and files, and whose chief customers are the butchers. It is better, however, that he should learn to do the work himself than trust to another. It is far better to be independent of another's aid in all operations of this kind, for when a man can do these things for himself the necessary work can be done at any time, whereas when the services of another must be invoked, the helped must await the convenience and coming of the helper, often to his serious detriment.

Itinerant Saw-setter

Amateur should learn to sharpen tools.

343. A saw seems a very simple thing, but it is surprising how few can sharpen and "set" a saw when it is a little out of order. If the amateur will look along the teeth of any saw used for cutting wood, that happens to be in good order, he will see that they do not lie straight, but that each tooth is bent outwards a little, either to the right or to the left, and that every other tooth is bent in the same direction; in short, the line of teeth will present an appearance similar to the annexed figure (fig. 139), which is rather exaggerated, for the sake of clearer illustration. In this figure, *a* is the point of the saw or part farthest from, and *b* the part nearest, the handle. If a line be drawn from point to point on each side of the diagram, it will be seen that they enclose a space of some width, wider, in fact, than the sheet of metal of which the saw is made. By frequent use these points get dulled and worn away, and the space is consequently diminished, and the operator finds it a difficult matter to get the saw through the wood in consequence of the increased friction between the wood and the saw-blade. To work pleasantly the blade of the saw should be thinner towards the back than it is at the edge, that is to say, in all kind of saws but tenon saws, whose back is strengthened by a bar of iron or brass to impart the necessary stiffness to the blade. The blade should also be kept well greased that it may not contract rust, which is detrimental to its working, as the amateur may find from experience.

Form of teeth of saw.

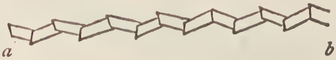


FIG. 139. TEETH OF SAW.

Saws should be kept greased.

344. Now in sharpening a saw, the first thing to be done is to recover the original width between the points by bending the teeth outwards, alternate teeth being bent in contrary directions. A saw-setter will set the teeth with a peculiar kind of hammer, striking every other tooth with unerring aim and surprising celerity, and then turning the saw over and repeating the operation on the remaining teeth. Great practice is of course necessary to do it with certainty, and the amateur is not recommended to attempt it. If he try his hand at it he will, without doubt, knock out several teeth, which will not at all improve the rasping or cutting power of the saw.

How to open teeth of saw.

345. What, then, is the amateur to do? He must have recourse to what is called a *saw-set*, an instrument of the shape shown in fig. 140, which consists of a round shaft formed like a turnscrew at one end, and terminating in a broad thick blade at the other, on either side of which are cut three or more deep nicks of different widths. Now if the saw be placed in a saw-vice—or between two boards, so constructed that the saw can be held lightly between them, with the teeth uppermost—the teeth can be bent to the right or left, as may be requisite, with the saw-set; each tooth being held in turn in the nick whose width will admit it most accommodatingly, and then bent by a slight pressure of the hand on the shaft of the saw-set. The difficulty here is in regulating the depth to which the tooth is buried in the nick, and the pressure which is applied. Occasionally the strain will be too great, and the amateur will have to experience the disappointment of snapping off a tooth. This may be obviated by the use of Hart's "Patent Saw-set," sold by Messrs. Churchill and Co., which is shown in fig. 141. This powerful but simple saw-set is made of the best malleable iron, except the set-lever, which is of the best cast-steel, properly tempered. To use it, the operator must first adjust the brass gauge to the tooth to be set, and then adjust the top till the gauge rests solidly on the saw-blade. It will be readily seen that more or less set can be given to the saw by turning the set screw on top

The saw-set: its actions.

FIG. 140. SAW SET.

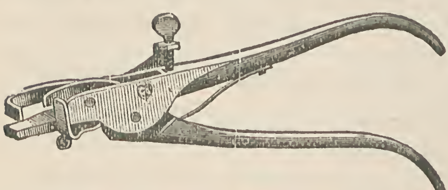


FIG. 141. HART'S PATENT SAW SET.

Hart's "Patent Saw-set."

up or down. The ordinary saw-set costs from 9d. to 1s. 3d.; the patent saw-set is more expensive, the 7½ inch set with single lever costing 2s. 8d. If fitted with a compound lever, a set of the same length cost 3s. 6d.; and a larger 10 inch set, also with compound lever, costs 6s. 8d.

Useful contrivance for saw-setting.

346. The following contrivance for the purpose of setting saws, which was invented by a practical workman, and used by himself and others to whom he showed it, has been found to answer its purpose perfectly well. In fig. 142, A shows the front view and B the side view of this useful apparatus. It has the merit of being exceedingly simple—so simple, indeed, and easy of construction that the amateur may easily make one for himself. The part marked A is made of wood, B is a steel punch working in a slide. This punch is cut down to half the thickness and chamfered down, as will be seen by referring to C and D, which are enlarged views of this punch. A cubical block of steel shown at E fits into a hole made for its reception in the part A. The edges of the block are chamfered or bevelled off to correspond with the chamfer of the punch, and each edge has a different chamfer to suit different saws. The action of this apparatus is as follows:—Supposing the amateur wanted to set his hand-saw—put the coarsest bevel of the steel block under the punch, lay the saw flat upon the block with one tooth under the punch. Give the punch a slight tap with a hammer. Serve every other tooth the same; turn the saw over, and repeat the operation. It is obvious that the teeth will take the same inclination outwards, as the bevel of the block and punch. After setting a saw it must be sharpened. For this end hold it in the vice with the teeth upwards, and with a saw file, give the teeth, if a handsaw, a shape like that shown at F; if a compass saw, a shape similar to G; and if a tenon-saw, the shape shown at H, taking care to file the teeth a little angular, as in fig. 139, showing the set of the teeth of a saw in page 145, and not straight across.

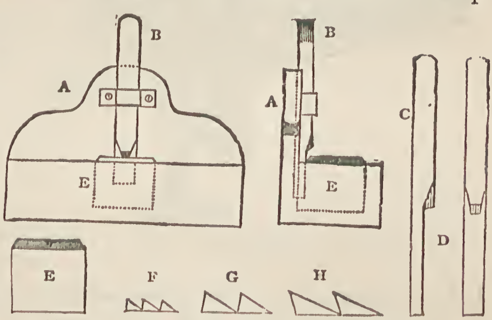


FIG 142. CONTRIVANCE FOR SAW SETTING.

Vice for holding saw.

347. With regard to the vice in which the saw must be held while

being filed, one of convenient construction is shown in fig. 143. This saw-filer's vice may be obtained from Messrs. Churchill and Co. for 6s. Its jaws are 9in. long, and it is jointed near the bench, by means of which the jaws can be thrown backward or forward at pleasure. The amateur, who cannot afford such appliances, may manage to hold his saw for the process of filing by means of his bench screw, which will be described in connection with the carpenter's bench. All that he has to do is to place a piece of ½in. board somewhat less in width than the saw near the handle, on each side of the saw, and then screw wood and saw tightly against the side of the bench with the bench screw. The piece of wood on the inside will keep the handle from touching the bench, if the saw be placed within the bench screw so that the handle is towards the right hand of the operator as he tightens the screw. Different saw files should be used for different kinds of saws. A tenon-saw file costs 3d., a file for a panel saw 3½d., for a hand-saw 4d., and for a rip saw 6d.

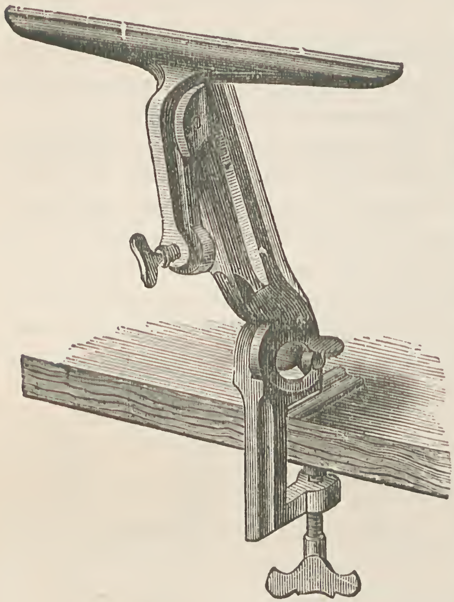


FIG. 143. SAW FILER'S VICE.

348. For sharpening or rather for grinding edge tools such as plane irons and chisels, the amateur must provide himself with a good grindstone. And here the opportunity must be taken to caution him against trusting his tools to itinerant knife-grinders and tinmen, who will in all probability spoil plane-iron or chisel, and render it utterly unfit for use. The reason, for the most part, is that they do not understand the work as regards tools of this description, and so make a mess of it. The edge of the plane-iron or chisel when ground and rubbed on the oil-stone should be a straight line as true and even between its extreme points as it is possible to make it. It stands to reason that if a plane-iron be in any

Edge tools should not be trusted to knife-grinders.

other condition than this as regards its edge, it will not touch the surface of a piece of wood alike at all parts of its edge, and the result will be that the surface will be taken off somewhat deeper in some parts than others, if it be possible to work at all with a tool in such a condition. The writer has had a plane-iron returned to him by an itinerant knife-grinder in a state that might be described in heraldic language as *wavy*, and chisels finished off with a slight bevel on either side after the fashion of a turnscrew.

Grindstones.

349. Grindstones can be purchased in many different sizes, and fitted up in many various ways. It is not desirable to have too small a grindstone for grinding plane iron, chisels, etc.; the best size for the amateur is from 12 inches to 18 inches in diameter, and from 2½ inches to 3 inches in width. The commonest form of fitting up is to rest each end of the axle of the grindstone on two parallel and horizontal bars supported on legs. The axle is prevented from jumping out of the grooves in which it is laid by iron loops or staples, and at one end it is square so as to receive the loop of a winch-handle, or handle shaped like the letter L, by which it is turned by one person while another applies the iron to be ground to the stone. It is most likely, however, that the amateur will be alone when at work, and it will therefore be desirable for him to have a grindstone so placed that it can be turned by the foot of the operator, by means of a crank and treadle. It is a good plan to have one end of the axle made into a crank for the treadle, and the other end squared to take an ordinary winch handle, as he can then avail himself of the aid of another in turning the stone, when opportunity offers. Useful stones are made with an iron frame and trough to hold water, and of such a size that they may be placed on the carpenter's bench. These are fitted with a telescope treadle, in some cases that they may be worked by the foot. Sometimes the grindstone is fitted with multiplying wheels, so that a considerable speed may be attained, as in the multiplying reel used by the fly-fisherman In fig. 144 is shown a grindstone placed on an ordinary bench, and with a crank and treadle. A is a trough in which water is kept during the operation, but as soon as the work is done the water should be poured away, as a stone should never be left to soak in water. The ends of the trough are raised so as to furnish a rest on which to steady the tool while grinding, as shown at B. It is better, however, to have a strong metal rest attached to the trough or framework by which the grindstone is sustained, in such a manner that the part on which the tool rests can be brought nearer

Useful grindstone for amateurs.

the stone, as at C. In some frames the trough is hinged at one end so that it can be raised or lowered at pleasure, so that when the trough is lowered the stone does not touch the water. Care must be taken that the stone is mounted in such a manner as to run truly, otherwise it is absolutely useless, and no tools can be properly ground on it. Grindstones, with and without frames, may be had at all prices from 6d. to 25s., though in some cases the nature of the frame on which the stone is mounted renders the price higher than the limit here given. The grinding surface of the stone must be kept level, otherwise it will be impossible to impart a straight edge to any plane iron or chisel.

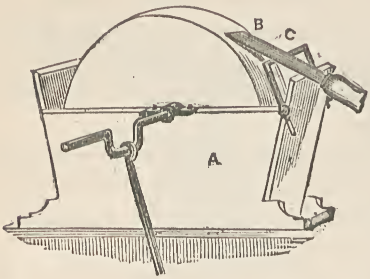


FIG 144. GRINDSTONE AND TROUGH.

Directions for grinding plane irons.

350. The author of "The Amateur Mechanic's Workshop" gives the following directions for grinding edge tools, which the amateur will do well to follow implicitly, as it is given by a practical workman of great experience. He says: "In grinding plane irons, chisels, and similar tools, *the stone should turn towards the operator*, and the tool should be held very firmly and quite squarely upon the stone, at a point sufficiently near its upper part to allow the tool to be in a nearly horizontal position, while its bevel lies flat upon it. If it is held too low, so that its handle points downwards, the water from the stone will run down the hands and arms, which is decidedly disagreeable, especially in winter. In addition the tool cannot be so firmly held nor the work so readily seen.

Gouges.

Gouges may be ground in a similar position, or (which is more easy and less likely to damage the stone) at right angles to it, *i.e.*, in the same direction as the axle; they must be rolled backwards and forwards as the operation proceeds. Keep the edges of the stone in use by constantly traversing the tool across its face, and never try to hurry the work by grinding to a more obtuse bevel than that made by the manufacturer. This is, indeed, generally rather more obtuse than it ought to be, and carpenters reduce this angle, and then the second bevel, formed by the oil-stone, restores it correctly.

Planes and Chisels.

In grinding planes and chisels, especially the first, it is as well for the amateur to make use of a square to test the correctness of the edge, otherwise the latter may not be truly at right angles to the side of the tool."

351. A little explanation with regard to the bevel may be useful. In 1, in fig. 145, is shown the manufacturer's bevel, that is to say, the slope at which the plane-iron or chisel is bevelled when ground by the manufacturer. The angle A B C is a very obtuse angle, and the angle B A D is a very acute one. In 2, C B A remains the same as far as the point A; but the bevel is rendered less obtuse by making the part from A to F slope at a different inclination by rubbing the iron on the oil-stone. This, of course, has the effect of making the angle A F D less acute than the angle B A D in 1. In 3 is shown the effects of bad grinding; during the process the tool has not been held firmly and flatly against the grindstone, and the slope from the thickest part of the iron to the point has assumed a slightly rounded form. Lastly, in 4 is shown, in an exaggerated form, the proper effect that should be produced when the tool is held firmly against the grindstone throughout the whole length of the bevel. As may be supposed, the surface produced is slightly concave, or somewhat hollow, corresponding to the convexity of the grindstone at any part of its circumference. Of course the larger the grindstone the less will be this convexity. When the tool has been rubbed on the oil-stone a part of the hollow from A to F is taken away, while that from A to B remains. Practically speaking, the effect produced is the same as that shown in 2.

Remarks on the bevel.

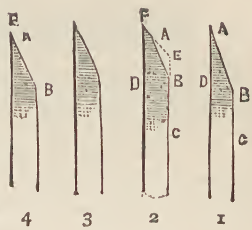


FIG. 145.

352. In grinding an axe or an adze, the edge of the tool is traversed across the face of the grindstone until the notches have been taken out, and the edge is clean and clear from one point to another. If it be desired to make the tool very keen in edge, recourse must be had to a slip of stone with which the edge must be rubbed until the tool is sharpened to the satisfaction of the operator.

Grinding adze or axe.

353. The oil-stone is constantly needed during all operations in Carpentry and Joinery in which the plane and the chisel is called into use. It is, indeed, wanted far more frequently than the grindstone, for this is only brought into use when the edge of the tool is altogether too dull to be sharpened by the oil-stone. There are two things to be taken into consideration here, namely, the nature of the oil-stone and the manner of using it, or rather, of applying the iron to it. Oil-stones are generally sold in a box, that is to say, the stone is set in a piece of wood so that its sur-

The oil-stone: how to use it.

face is perfectly level, and over it a loose cover is fitted, made of the same kind of wood, which preserves it from dust and injury when out of use. The oil-stone, as set in wood and provided with a cover is shown in fig. 146.

354. The most serviceable sized oil-stone for the amateur is one about 2in. wide and 8in. or 9in. long, and if one can be procured that is a little wider it should be taken in preference to a narrower one. A stone should be neither too hard nor too soft, as a soft stone will soon wear, while a hard stone grinds slowly, and through the iron not biting fairly on its surface, some time is taken in putting a good edge to it, that is to say, an edge of the necessary fineness, smoothness, and keenness. Sometimes, too, a stone is met with which has a hard spot in it, over which the tool slips, and as the rest of the stone wears away the hard spot forms a rounded protuberance, rising slightly above the level of the other part. On such a stone as this it is impossible to sharpen a tool properly.

Size desirable for oil-stones.

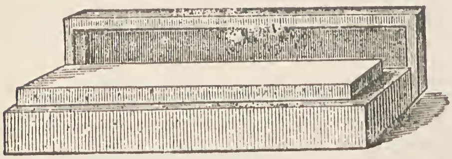


FIG. 146. OIL-STONE IN BOX.

Turkey stones. Turkey stones are considered to be the best, and they are so undoubtedly when they are really good, and next to these in quality are the Arkansas stones. Washita stones, another variety of American oil-stones, are also very good. And of stones of this description procured at home, the Charley Forest (properly Charnley Forest) oil-stone is as good if not superior to any others. Good oil-stones, whether from Turkey or the United States are generally sold by the pound, the price per pound ranging from 1s. 6d. to 2s. Messrs. Churchill and Co. sell Washita stones in different sizes at 2s. per pound. and gouge slips (for gouges cannot have an edge given to them on the flat oil-stone) at 4s. per pound. Again, stones mounted in oak are sold by this firm at the following prices, according to the sizes given, namely, with stone 4in. × ⅞in., 6d. ; 6in. × 1½in., 2s. 8d.; 8in. × 2¼in., 4s. ; 9in. × 2¼in., 4s. 6d. By other dealers Arkansas oil-stones are sold from 6s. to 8s. 6d. each, and slips of the same from 1s. 6d. ; Turkey oil-stones from 4s. each, and slips from 1s. 4d. ; Washita oil-stones from 1s. 9d. to 3s. 6d., slips from 10d. to 1s. 3d. ; and Charnley Forest stones from 1s. to 2s. each, and slips 6d. each. These stones are without mountings, for which an addition is made to the prices above given.

Washita stones.

Prices of oil-stones.

355. In using the oil-stone a few drops of olive oil should be squirted on it from the oiler as soon as the surface has been wiped perfectly clean. Paraffin is sometimes recommended instead of olive oil, but the latter is quite as good as a lubricant for the stone, and is free from the offensive smell which is given out by paraffin. The great difficulty that the amateur will experience in setting a tool on the oil-stone lies in keeping the bevel at the same angle with the stone throughout the operation. As he moves the tool backwards and forwards along the stone, he is apt to give it a different inclination when close to him than when at a greater distance from him, the angle at which the tool is inclined to the stone being greater when in the former position and less when in the latter. The writer from whom we have already quoted with regard to the proper method to be adopted in grinding plane-irons, etc., says, with reference to the manner in which the tool should be held while rubbing it on the oil-stone :—

Lubricants for oil-stone.

356. "It is evident that the tendency to be aimed at is the raising of the handle slightly as the tool moves further from the person, instead of allowing it to take the positions shown (that is, different angles of inclination to the stone during its passage backwards and forwards). All *guides* are to be discarded both for the grinding and setting (the rest on which the tool is sustained when held on the grindstone being excepted). They are as bad as corks and bladders in teaching a person to swim, for it becomes exceedingly difficult to do without them ; and it is evident from the daily practice of carpenters that however difficult the right method may be to acquire, it is by no means impossible, and is, moreover, of absolute necessity. Square the elbows, let hand and arms have freedom, grasp the tool above with the right hand so as to bring the fingers underneath it, and let the fingers of the left lie together, and straight upon the upper side, their ends tolerably near the edge of the tool, the thumb being underneath. The tool will be thus held firmly, and also under control. Holtzappfel gives a different way, the reverse of this. He says the first finger only of the right hand should be held above, and the thumb and rest of the fingers below, the left hand grasping the right, with the finger above the tool and the thumb below. It is probably in a great measure a question of habit."

Position of tool.

Guides: why undesirable.

Position of hand, arm, etc.

357. It is said that edge tools may be sharpened by plunging them in a bath of muriatic acid, diluted to a considerable extent with water, and leaving them exposed to the action of the acid for a short time.

The acid will act on every part of the blade with which it comes in contact, and will eat away a thin coating of metal, thus fining down the point or edge of any tool, which must now be rubbed on the oil-stone in order to impart a polish to the bevel and keenness to the edge. It must be remembered, however, that if the edge of the tool that is subjected to the action of the acid be not perfectly even and uniform, no eating away of the surface of the metal by this means will make it even: to take out notches, etc., by immersing a tool in a bath of muriatic acid and water is simply impossible, for the action of the acid is alike and equal on all parts of the surface exposed to it. It is better to learn to sharpen tools by the aid of the grindstone and oil-stone than to trust to any chemical action to produce the desired results.

Sharpening tools by immersion in acids.

358. The following remarks relative to the above process appeared in "Design and Work" some time ago, and are here reproduced for the information of those who may wish to try it. "It has long been known that the simplest method of sharpening a razor is to put it for half an hour in water, to which has been added 1-20th of its weight of muriatic or sulphuric acid; then lightly wipe it off, and after a few hours set it on a hone. The acid here supplies the place of a whetstone, by corroding the whole surface uniformly, so that nothing further than a good polish is necessary. The process never injures good blades, while badly hardened ones are frequently improved by it, although the cause of such improvement remains unexplained." Again, it is said that as it is with razors so it is with scythes and sickles, and, as a natural consequence, so it must be with all other kinds of edge tools. With regard to scythes and reaping-hooks, "the time lost in the harvest field in the early morning would be spared by laying the blades for half an hour in a bath prepared as above described. As soon as they are taken out of the bath they should be wiped, and a soft sandstone hone passed along would leave a good and uniform edge behind it."

Remarks on this process.

359. Grindstones for razors and the finer kinds of edge tools in which the keenest possible edge is a desideratum, may be made by artificial means. Silicious sand of great fineness, or emery powder, and shell lac are taken in the proportion of three parts of the former to one of the latter. The sand must be well washed and the shell lac melted, after which the sand must be stirred into the melted lac and will incorporate with it while it is warm. The composition is placed in a circular mould with a space in the centre to form a hole, square in shape, for the axle, and then left to harden.

Artificial grindstones.

360. It is to be feared that the amateur's tools will sometimes be allowed to get rusty by being left for a short time in the rain when working out of doors, or by the dampness of the shed or workshop in which he carries on his operations. This is a very fruitful source of rust in tools, and even if the shed be perfectly water-tight the dampness in the air itself during prolonged rain and wet seasons will frequently do much mischief. The following is a simple method of removing rust from steel which will be found useful :—

To remove rust from tools.

Recipe. — *To remove rust from steel.* — "Cover the metal with sweet-oil well rubbed in and allow to stand for forty-eight hours, smeared with oil applied freely with a feather or piece of cotton wool, after rubbing the steel. Then rub with unslacked lime reduced to as fine a powder as possible."

361. Another method is given by Spon in his "Workshop Receipts," a most valuable book, replete with information on a wide variety of subjects which may be recommended to the notice of the amateur as a candidate for a place on his bookshelves. It is as follows :—

To extract rust from steel.

Recipe.—*To extract rust from steel.*—"Immerse the article to be cleaned for a few minutes until all dirt and rust is taken off in a strong solution of cyanide of potassium, say about half an ounce in a wineglassful of water ; take out and clean it with a tooth-brush with some paste composed of cyanide of potassium, Castile soap, whitening, and water ; these last are mixed in a paste about the consistence of thick cream."

Preventives against rust.

362. Prevention, however, will be deemed by many far better than the cure, as given above ; and when tools have to be left in a shed or workshop without any means of warming it throughout the winter months, when they are seldom used, it may be profitable to subject them to some such treatment as the following, which is also borrowed from Spon's "Workshop Receipts" already quoted above :—

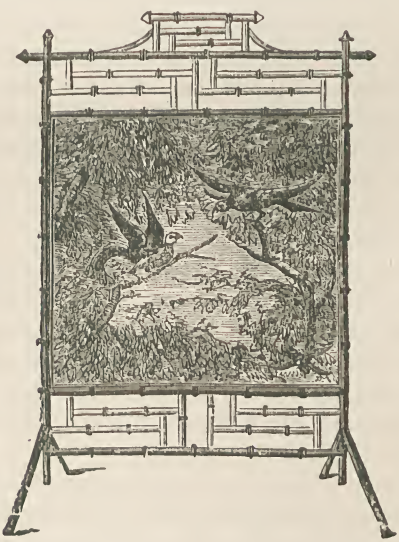
To prevent tools from rusting.

Recipe.—*To prevent tools, etc., from rusting.*—"1. Boiled linseed oil will keep polished tools from rusting, if it is allowed to dry on them. Common sperm oil will prevent them from rusting for a short period. A coat of copal varnish is frequently applied to polished tools exposed to the weather. Woollen materials are the best for wrappers for metals. 2. Iron and steel goods of all descriptions are kept free from rust by the following :— Dissolve ½oz. of camphor in 1lb. of hog's lard, take off the scum and mix as much black lead as will give the mixture an iron colour. Iron and steel and machinery of all kinds rubbed over with this mixture

and left with it on for twenty-four hours, and then rubbed with a linen cloth, will keep clean for months."

Varnish to prevent rust.

RECIPE.—*Varnish to prevent rust.*—"Rosin, 120 parts; sandarac, 180; gum lac, 60; essence of turpentine, 120. Take the first three ingredients in a pounded condition, and digest them by a regular heat till melted; then add the turpentine very gradually, stirring all the while. The mixture should be digested until dissolution, then add rectified alcohol, 180 parts. Filter through fine cloth or thick bibulous paper (blotting paper), and preserve in well stopped bottles or cases."



CHAPTER VI.

HOW TO HOLD AND HANDLE TOOLS, AND HOW TO USE THEM.

How to learn to use Tools—Reference to order in which Tools will be taken—Striking Tools—The Hammer : how to use it—How to strike Nails—Hole for reception of Nail, etc.—The Mallet : how to use it—How to use the Axe or Hatchet—The Adze and its uses—Adze a dangerous Tool—Rasping Tools—Right mode of holding Saw—Position of first Finger and Elbow—How to steady Wood—How to keep Wood steady—Inclination of Saw—Head of Operator : how held—Process of Sawing—Cautions in Sawing—Mistakes made by Amateur—Marking Guide-line in Sawing—Wrong way of making line—Instruction to be derived from remarks—Carpenter's method of marking line—Cutting down long Board—To prevent Saw from "hanging"—Ripping down Planks—Cutting Tenons—Things to be remembered when Sawing—How to use Rasps—Filing Metal—Frame Saw : its uses—Cutting out a Keyhole—Paring Tools—Planing and Sawing chief Operations in Carpentry—Jack-plane : why so called—Cutting iron of Jack-plane—Construction of Plane-iron—How to hold the Jack-plane—American Iron Planes — Smoothing-plane : its construction — How to hold Smoothing-plane—Planing Boards and Scantlings—Planing in direction of grain—No fixed Rule—Removal of Plane-iron—Adjustment of Iron—Sole of Plane : its use—Difficulty in Planing : how caused—Proper positions of Brake-iron and Cutters—Mode of looking at Adjustment—Planes for Rebating, etc.—Rebating : what it is—Cutting Rebate—Side Fillister—Bull-nosed Rabbet-plane—"Stanley" Iron Plane—Mode of holding Rebate-plane, etc.—Attachment to Rebate-plane—Match-planes—Why so called—Plough for cutting Grooves—Old Woman's Tooth—American Combination Planes—Bits supplied with Plane—These Tools seldom required by Amateurs—Trant's Adjustable Dado, Filletster, and Plough—Drawingknife and Spokeshave : how to handle them—Modes of using Chisels and Gouges — Chisels : their varieties — Mortise and Tenon—Meaning of "Tenon"—Meaning of "Mortise"—Chisel in cutting Mortise—How it should be held—Paring Chisels, etc. : how to hold them—The Gouge : how to hold it—Use of boring Tools, etc.—Boring with Bradawl and Gimlet—How to hold Bradawl—The Gimlet : how to hold it—The Auger : how to hold it—Position when using Brace and Bit—Boring holes with Brace and Bit—Use of marking Gauge—Mortise Gauge—The Nail Punch : how to hold it.

363. HAVING provided himself with the necessary tools described in a preceding chapter, or such a selection from the whole as may best meet his requirements, the next thing to be done is to learn how to use them. It is next to impossible to do this from printed instructions; and on the principle that a little showing is better than a great deal of telling, the best advice that can be given to the amateur on this head is that on which some stress has

How to learn to use tools.

been already laid, namely, that he should arrange with some skilled artisan to give him a few practical lessons in the method of holding, using, managing, and sharpening his tools, and the everyday operations in Carpentry and Joinery, such as sawing, planing, scarfing timbers, cutting rebates, mortises and tenons, dove-tailing, mitring, etc., etc.

Reference to order in which tools will be taken.

364. We will take the tools *seriatim* in the same order in which they have been described in Chapter IV., and to prevent useless repetition the reader is referred for this order to page 77, in which he will find it duly set forth.

Striking tools.

365. In accordance with this order the first set of tools that we have to deal with are *striking tools*, which comprise hammer and mallet in one division, and adze and hatchet or axe in the other.

The hammer: how to use it.

366. The handle of the hammer should be grasped at a short distance above the end of the handle, that is to say, in such a way that the end of the handle projects about an inch or more beyond the side of the hand, in the manner shown at A in fig. 147. The hand and the eye act so well together in concert, that after a little practice the amateur will find no difficulty in hitting

How to strike nails.

the nail direct on the head whenever he strikes it. If the nail be struck by the centre of the hammer head, as it should be as at B, it will soon be sent straight to its destination; but if it be hit by any part of the face near or on the edge, as at C, the force of the blow will be partly lost, and the nail will be bent sideways, or otherwise moved out of position. The face of the hammer should be perfectly flat; when used overmuch it is apt to get rounded, especially if it be of inferior quality, and then it must be got rid of, and its place supplied with a better. A hole with the bradawl or gimlet should be made for the reception of every nail that is hammered in and every screw that is driven into wood. The nail will go in all the straighter for it. Sometimes a knot or any hard substance within the wood will cause the nail to swerve from the right direction and even to curl up, thrusting the point through the wood at no very great distance from the hole at which it has entered, "coming out," in workman's parlance, "to have a look at the fool that is driving it." A *contretemps* of this kind may often be saved by preparing a way for the nail by the bradawl or gimlet.

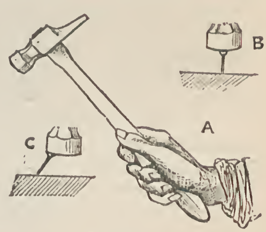


FIG. 147. HOW TO HOLD THE HAMMER.

Hole for reception of nail, etc.

367. The mallet is held in the same way as the hammer, but rather higher up the handle, as the head is larger and heavier. In striking any tool with the mallet care should be taken to deliver the blow so that the end of the handle of the tool is hit with the centre of the face of the mallet.

The mallet: how to use it.

368. The axe must be grasped with the right hand, at a distance of about one-third from the end of the handle; but the position of the hand will be regulated in a great measure by the material with which the edge is brought into contact, or the extent or weight of the blow that it is desired to strike. Thus, to deliver a heavy blow, the handle must be grasped close to its end, but to give a light blow the hand must be moved upwards along the handle until it has nearly reached the head. When turned, the flat part of the head may be used in place of a heavy hammer or mallet in driving the timbers of any piece of framing into place, but on no account must it be used for driving nails. If at any time the amateur finds it necessary to drive nails, he should provide himself with a heavy hammer of the kind used by carpenters for rough heavy work. In chopping a piece of wood with the hatchet—as for example in sharpening the end of a stake to be driven into the ground—the end to be sharpened should be placed on a trestle—a description of narrow stool—and held by the left hand, which should be kept well out of range of the hatchet. A carpenter will use the axe for shaping a wedge out of a short piece or block of wood, but the amateur is recommended to do this with the paring chisel, lest by an unlucky blow he injure his hand with the sharp edge of the hatchet. The mode to be adopted in holding axe and wood is shown in fig. 148.

How to use the axe or hatchet.

Fig. 148. HOW TO HOLD THE HATCHET.

369. The adze is used for chipping away the surface of wood placed in a horizontal position so as to produce a level surface, or one that is nearly so. The operator stands on the wood and uses the tool after the manner of a hoe. The projection on the head of the adze is called its pole, and may be used, if needs be, as a hammer. The adze is one of the most dangerous of all tools to use, but it is far from likely that any amateur artisan will ever be obliged to call it into requisition.

The adze and its uses.

Adze a dangerous tool.

370. Next in order to the striking tools come the *rasping tools*, under which head are included every variety of saw, and rasps and

files. The purposes to which these tools have been put have been already pointed out, and it only remains to point out here the way in which each is to be used, so as to effect the desired purpose.

Rasping tools.

371. It is difficult to show the position of the hand when holding the saw in a single drawing, as both sides of the saw-handle cannot be seen at once; recourse must therefore be had to two, as in the annexed illustration, in which each side of the hand is exhibited, after the manner of the obverse and reverse of a coin. In taking hold of the handle of a saw all the fingers except the first finger are passed through the loop of the hand-saw, or round the handle of the tenon saw; the handle of this kind of saw being somewhat differently formed. The position of the thumb and the second, third, and fourth fingers are shown at A in fig. 149, the first finger is laid along the side of the handle as at B. The position of the first finger tends to assist the operator in a wonderful degree in steadying and directing the saw, and keeping it upright. The elbow of the right arm should be kept well into the right side so as to strengthen the forearm, or rather to keep it as straight as possible, and in a direction corresponding to that of the wood that is being sawn.

Right mode of holding saw.

Position of first finger and elbow.

How to steady work.

FIG. 149.
HOW TO HOLD A SAW.

372. The wood should be steadied with the left hand, or if it be a short piece, held firmly by it. In sawing down a plank on one or two trestles, as the case may be, the right knee and foot should be placed on the board, partly to keep the board steady and partly to keep the body of the operator steady. In ripping down a plank or in cutting a piece of wood across the grain, the hand-saw—and any saw of this shape, as the rip saw, half rip, and panel saw—should be held at an angle of 45° to the horizon, or very nearly so. This will serve as a general guide, for the inclination of the saw must be suited in a great measure to the position of the wood and the nature of the work to be done. For example, in cutting a tenon, either with the hand-saw or tenon saw, the edge of the saw must be kept parallel to the surface of the wood that is being cut, or very nearly so. The head of the operator should be held directly over the saw, so that the eyes may look down on both sides of the saw. In beginning to make an incision with the saw, the up-and-down motion should be

How to keep wood steady.

Inclination of saw.

Head of operator: how held.

started very gently with very short strokes, and no force should be applied to the saw until it has entered for about an inch into the board.

373. As the saw cut lengthens more force may be gradually applied, but whatever force may be used it must only be applied in the downward stroke, for it is in this motion only that the saw cuts; in the upward motion it should be merely drawn up. The saw should be held upright, or in other words, the blade should always be at right angles to the surface of the board through which it is cutting, above and below, for if it incline to the right or left to the slightest degree, it is manifest that the friction between the saw cut and the sides of the saw will be increased, by reason of the cut being out of the proper direction in relation to the plane of the surface of the board. Care should be taken to avoid short jerky strokes, but in the upward stroke the saw should be drawn up to within an inch or two of the point, and in the downward stroke pressed with force against the wood that is being sawn asunder, until the wood is within an inch or two of the bottom of the blade or very near the saw handle. By this means the whole length of the blade, or very nearly so, is brought into play. In drawing the saw upwards, on no account draw it through and out of the wood, for in the delivery of the downstroke, which follows immediately, before the operator is conscious of what has happened, the point may be driven with force against the wood, if not into it, and bent in one direction or another, thus seriously jarring and injuring the saw.

Process of sawing.

Cautions in sawing.

374. The mistakes usually made by the amateur when sawing are three in number: *Firstly*, he is apt to put all four of his fingers through the looped handle of the saw, instead of laying the first finger along the side of the handle that is outwards or furthest from him. *Secondly*, he forgets to keep his eyes directly over the saw-blade, so that he may see both sides of the blade, as he may prove to himself by shutting first one eye and then the other, looking downwards on the blade as he does so, or what is much the same, a long narrow line of steel formed by the line of the back and the points of the teeth projecting slightly beyond it on either side. It is manifestly impossible to saw straight if the back of the saw and the saw cut already made and the line of guidance for the saw cut, if it were possible to see it as well as the back of the blade and the saw cut, be not so placed in relation to one another so as to form a narrow straight line from one end to the other of the board that is being cut. *Thirdly*: Instead of allowing the arm free play and motion, and permitting it to form a connecting link

Mistakes made by amateur.

between the saw and the body—as the arms in rowing form a link between the body and the oar, transmitting the weight of the body as the power which acts on the boat through the oar as a lever—it is held stifly, and far more force applied than that which is necessary to send it through the downward stroke. This has the consequence of bending the saw too much to the left for the most part, and making the work difficult through the amount of friction that is caused by the blade and the saw cut being at an angle to the plane of the surface of the board instead of perpendicular to it. When these points have been corrected by the amateur artisan, he will have advanced some steps in the way of being a fairly good workman.

Marking guide-line in sawing.

375. A few hints and cautions yet remain to be given with regard to the operation of sawing. It is better in ripping down a plank, or in making any saw-cut of considerable length, to mark the guide-line on its surface with the line and reel (see page 111), by means of which the line connecting any point in one end with any point in the other is struck perfectly straight and true. If the board be not longer than any straight-edge that the amateur may have, the line from point to point may be ruled in pencil with its aid.

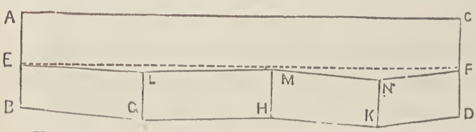


FIG. 150. FAULTY METHOD OF TRACING LINE FOR SAW-CUT.

Sometimes the amateur will trace a line for a saw-cut, by measuring the length between the edge of the board and the point in its end, and then taking off-sets from the edge along the whole, at distances corresponding pretty nearly to the length of the ruler or straight-edge with which he is going to rule the lines, that together will form the whole line from end to end, as in fig. 150. Now the ends

Wrong way of making line.

A B and C D of the board A B D C being equal, and being, for the sake of argument, six inches long, if A B and C D had been bisected or divided into two equal parts in the points E and F by aid of the chalk line and reel, a perfectly straight line could be struck from E to F, as in the dotted line E F. But suppose off-sets equal to B E or F D, that is to say, of three inches, had been set off along the board from the edge B D, at the points G H K to the points L M N, then when the whole line E F has been ruled in short lengths, E L, L M, M N, and N F, a line from E to F is obtained which is anything but straight, and to cut which undue pressure will be laid on the saw to carry it along the various turnings and twistings, and after a few of such essays the saw will be found to be considerably

strained and perhaps crippled. The mischief has been caused by the edge B G H K D being anything but straight, and the instruction to be derived from all this, and carefully laid to heart withal, is—unless the edge of your board has been properly planed up, and is perfectly straight—to make the line to guide your saw-cut with the line and reel, or a straight-edge long enough for the purpose. When the edge has been properly planed up, a line parallel to it may be drawn by very simple means. Thus a carpenter will often hold a rule in one hand, letting just so many inches, etc., as may be requisite project over the board and lay upon it, and pressing the point of a pencil, held in the other, against the end of the ruler, and on the surface of the wood draw a straight line parallel to the edge by moving the hand that holds the ruler along the edge of the board, and carrying the pencil along with the other closely pressed against the ruler and on the board throughout the entire length of the line that it is desired to make. The method of doing this, as described, may be better understood by a glance at fig. 151.

Instruction to be derived from remarks.

Carpenter's method of marking line.

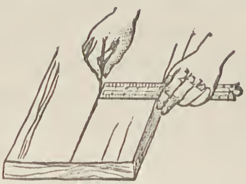


FIG. 151.
HOW THE CARPENTER DRAWS A LINE.

376. In cutting down a long board, the board will be rendered more rigid and the progress of the saw facilitated by inserting a wedge of wood into the commencement of the cut. If it be found desirable, the wedge may be moved down the saw-cut as the sawing proceeds. If the saw "hangs" at all, or, in other words, if the friction between the wood and the sides of the saw be greater than it ought to be, owing to the blade being rusty, or the teeth worn and in want of sharpening, a little grease or tallow should be rubbed on the teeth and blade of the saw.

Cutting down long board.

To prevent saw from "hanging."

377. For ripping down planks, that is to say, for cutting with the grain of the wood, the rip-saw or half rip-saw is used. This saw, however, is by no means necessary to the amateur, as the work of ripping down can be done as well, though perhaps not so quickly, with the hand-saw, which will cut as well across the grain as with it. Tenons of large size can be cut with the hand-saw or tenon-saw; but all dove-tailing should be done with the sash or small tenon-saw. Whatever may be the nature of the work, or whether the cut be with the grain or across the grain, the amateur artisan must bear in mind that: *No saw*

Ripping down planks.

Cutting tenons.

cut should be made without first marking the wood with a chalk or pencil line, as a guide-line. And in addition to this, for safety's sake, as long as he is a novice in the art, when making a long saw-cut it is better to *mark a line on both sides of the wood, so that during the operation the board may be turned over now and then, that it may be seen whether or not the cut is being carried exactly in the right direction.*

Things to be remembered when sawing.

378. In using large rasps or files, whether for wood or iron, the work should be held in the vice or otherwise firmly fixed so that it cannot move, unless it can be conveniently steadied with one hand during the operation. It is desirable, however, to use both hands when possible, the handle of the tool being grasped by one hand, while the other is pressed, but not too heavily, on the end of the blade, or near the end, so as to lend weight to the tool and additional effect to its powers of abrasion. The flat side of the rasp may be used for any kind of work, but the rounded side will be found more handy for rasping down the edge of a round hole, so as to give it a bevelled as well as rounded surface. Small files for cutting metal may be worked backwards and forwards; but in using these, as well as saw-files, a forward cut continually repeated is better.

How to use rasps.

Filing metal.

379. Little or nothing need be said here about the use of the frame saw or the keyhole-saw. The frame-saw in its larger variety is not an easy tool to use until the operator has become pretty well accustomed to it, and then it is said to be easier to work than the ordinary saw. The small frame-saw is used in fret-cutting, which will be mentioned elsewhere. The keyhole-saw, being very narrow in the blade, is used for cutting small holes, such as keyholes, as the name implies.

Frame saw: its uses.

380. To cut out a keyhole, two holes are generally turned through the wood by the aid of the brace and bit, and the piece that separates them is then taken out with the keyhole-saw, as shown in fig. 152. The keyhole-saw is also used for cutting curved lines, as the circumference of a circle in a piece of wood. An opening is made with a gimlet or brace and bit, through which the narrow saw blade can be passed, after which the blade will work its way round in either direction, as may be required. The compass-saw is also used for circular work. This kind of saw consists of a blade about 1in. or 1½in. at the handle, and tapering away to a point, set in a handle resembling that of a tenon-saw.

Cutting out a keyhole.

FIG. 152. CUTTING KEYHOLE.

381. The chief of the three groups of tools included under the general head of *paring tools*, comprises planes of all kinds. The other two groups are formed, the one by the drawingknife and spokeshave, the other by the chisels and gouges. We will take the planes first of all, and consider, firstly, the mode in which the long planes are used—such as the jack-plane, the trying-plane, and the jointer-plane; secondly, the smoothing-plane, and the smaller varieties of this class; and, thirdly, the planes that are used in grooving and tonguing—as match-planes, rebate-planes, ploughs, and others of a similar kind. It will be endeavoured to restrict our consideration of this large and important class of tools to its narrowest limits, consistent with the fact that planing is one of the two great operations in carpentry and joinery, sawing being the other, that require the closest attention and practice on the part of the amateur.

Paring tools.

Planing and sawing: chief operations in carpentry.

382. It may not be uninteresting to some to pause a moment, and inquire why a jack-plane should be so called. It is used for rough and coarse work, mainly for taking off the rough and ragged surface of sawn timber and leaving it in a better condition for the action of the smoothing-plane, by which the inequalities left by the jack-plane are removed, and the whole surface rendered smooth, level, and perfectly even. Wedgewood in his "Dictionary of English Etymology," when treating of the origin of the term "jack" as applied to various contrivances, tells us that "the Jewish *Jacobus* was corrupted through *Jaquemes* to *Jaques* in France and *James* in England, and *Jaques* being the commonest Christian name in the former country was used as a contemptuous expression for a common man. The introduction of the word in the same sense into England seems to have led to the use of Jack as the familiar synonym of John, which happened to be here the commonest name, as Jaques in France.

Jack-plane: why so called.

> 'Since every Jack became a gentleman,
> There's many a gentle person made a Jack.'—*Richard III.*

The term was then applied to any mechanical contrivance for replacing the personal service of an attendant, or to an implement subjected to rough and familiar usage. A *roasting-jack* is a contrivance for turning a spit, by means of a heavy weight, and so superseding the service of the old turnspit. A *jack*, a screw for raising heavy weights. A *boot-jack* (German, *stiefel-knecht*, literally, 'boot-boy'), an implement for taking off boots. A *jack-towel*, a coarse towel, hanging on a roller for the use of the household; *jack-boots*, heavy

boots for rough service; *black-jack*, a leathern jug for household service; *jack-plane*, a large plane for heavy work."

383. From this digression let us turn to the manner of holding the jack-plane and how to use it. Some jack-planes are made with a single iron only, but it is better for the amateur to have one that is fitted with a double iron. A section of the plane-iron is figured in page 88, in which the object and use of each iron is shown; the lower iron being the *cutter* by which the shaving is cut from the wood, and the one on the top of it, whose bevel is turned in the opposite direction, being the *break-iron* by which the shaving is turned in its upward course, so as to pass more readily through the aperture cut in the *stock* of the plane, as the wooden block is called in which the iron is set. It will be noticed that the break-iron, or back iron, as it is often called, is held to the cutter by means of a broad-headed screw that enters a nut on the upper side of the break-iron, and that there is a long slot in the cutter so that the break-iron may be moved nearer to or farther from the edge of the cutter at pleasure. Now the chief use of the break-iron is to adapt the cutter for use in different kinds of work, and the break-iron must be regulated according to the nature of the work to be done with the plane. Thus when the jack-plane is required for heavy work, that is to say, for hacking down a rough and uneven surface, the edge of the break-iron should be about ⅛ inch from the edge of the cutter, but for finer work it should not be more than $\frac{1}{20}$ inch from the latter; and in the smoothing-plane the distance between the edges of the two irons should be less than this—indeed so slight as to be perceptible, but nothing more. The higher the break-iron, the easier the plane will be found to work, and the lower it is the heavier the plane will work, but the cut will be cleaner.

Cutting iron of jack-plane.

Construction of plane-iron.

384. To hold the jack-plane when in use, the handle must be grasped firmly with the right hand, the forefinger being extended and placed against or by the side of the wooden wedge by which the iron is held in the stock; the left hand is placed over and on top of the stock, in front of the iron, as shown in fig. 153, the thumb being on the side of the plane nearest the operator. Heavy pressure of the left hand in this position is necessary, in order to keep the fore-part of the plane well down, so that the iron may take firm hold of the surface of the wood. At this time, namely, during the first part of the cut, the pressure with the right hand on the back part of the plane should be somewhat relaxed and lessened; but when the cut is approaching

How to hold the jack-plane.

completion the mode of procedure should be reversed as far as pressure is concerned, and pressure of the right hand should be increased, and that of the left hand lessened. The amateur, unless he has a trying-plane, will use his jack-plane for shooting the edges of boards. In performing this operation the plane is held in a different manner. The handle is grasped by the right hand as before, but the left hand is

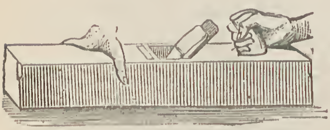


FIG 153. HOW TO HOLD JACK-PLANE IN "FACING UP."

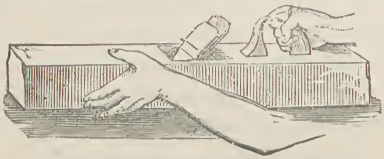


FIG. 154. HOW TO HOLD JACK-PLANE IN SHOOTING EDGE OF BOARD.

placed by the side of the plane nearest the operator, the thumb being on the upper surface, the first and second fingers along the side, and the third and fourth on the sole or under part, forming a sort of gauge or stop to regulate the passage of the plane along the wood. The manner of holding either the jack-plane or trying-plane in shooting the *edges* of boards is shown in fig. 154. The method shown in fig. 153 is that adopted in planing the *surface* of a board, or, in technical language "facing up."

385. It must be understood that although wooden planes are figured in the illustrations the general method to be followed in holding the American iron planes is the same, some slight modifications being rendered necessary on account of the difference of construction. But by following the general instructions above given, the operator cannot fail to handle an American plane as readily and as easily as the old-fashioned wooden one.

American iron planes.

386. The smoothing-plane, as it has been already said, is used for cleaning off or reducing to smoothness and a perfect level, the surface from which the rough exterior has been already taken by the jack-plane.

Smoothing-plane: its construction.

FIG. 155. HOW TO HOLD SMOOTHING-PLANE.

The distance between the edges of the cutter and the break-iron has been mentioned, but it may be as well to repeat here that it must not exceed $\frac{1}{24}$ inch, and may be even less with advantage. The plane has no handle, and must be held as shown in fig. 155, the right hand being placed over the stock of the tool, grasping it firmly, just behind the iron and wedge, and the left hand by the fore part of the side next the operator, the fingers being turned

How to hold smoothing-plane.

over the front, and the thumb on the top, the fore part of the plane being completely covered by the hand of the operator. The strokes or cuts that are made with the smoothing-plane are short and quick, and sometimes a motion that may be described as curvilinear, or like a slight circular sweep, is given to the plane.

Planing boards and scantlings.

387. There are other points, in addition to the method of holding the plane, that require attention ; and these are the direction in which boards and scantlings are to be planed, and the manner in which the plane iron is to be taken out of the stock and replaced, when necessary, for sharpening; or the regulation of its projection beyond the sole or under surface of the stock effected.

Planing in direction of grain.

388. And, first, with regard to the wood that is to be planed. This must be laid flat on the bench, with one end abutting on the wood stop, that is fixed in the bench in such a manner that it can be raised or lowered at pleasure, according to the thickness of the wood to be planed. All planing must be done in the direction of the grain of the wood, in order to obtain a perfectly smooth surface. This may be rendered more intelligible by the aid of fig. 156, in which a piece of wood is represented in section. In this the fibre or grain of the wood lies in one direction from A to B, and in the other from A to C. Now in planing the surface B C of such a piece of wood, the plane must be first worked over it from A to B, and then from A to C, in the directions indicated by the arrows. If it were attempted to plane the wood right along from C to B, or from B to C, during the first part of the operation in either direction, the cutting edge of the plane would strike against the projecting edge of each successive layer of fibres; and if the wood were soft as in fir, and the edge of the cutter were not too keen, it would bend them back, and here and there the smooth surface would be broken by a rough ridge. This must be obviated by planing the wood first in one direction and then in the other, to suit the grain. No fixed rule can be laid down, but the operator will very soon find from the behaviour of the tool he is using, in which direction it ought to be worked. In the illustration the space between E and F may be worked either way. In planing wood rough from the saw, the plane should be worked for the most part in the direction of the saw cut, the rough particles being bent in one direction by the action of the teeth and sides of the saw.

FIG. 156. GRAIN OF WOOD.

No fixed rule.

389. To remove the plane-iron and the wedge by which it is held in place, the amateur artisan, unless he has been instructed in the proper mode of performing this operation, will, in all probability, try to accomplish it by knocking wedge and iron first on one side and then on the other with a hammer. Such a course will spoil the plane. To loosen a plane-iron in order to remove it for sharpening, etc., hold the stock of the plane in the left hand, which should be placed over the upper surface in front of the wedge, and with a hammer or mallet held in the right hand, strike the stock lightly and quickly on its heel or back. This will loosen the iron sufficiently to admit of its removal with the thumb and finger. In like manner, when it is desired to lighten the wedge that holds the iron, or to make the edge of the cutter project a little more beyond the surface of the sole of the plane, all that is necessary is to strike the stock on the front in a manner precisely similar to that adopted for loosening the iron by striking the heel of the plane. Neither the wedge nor the plane-iron should, as a rule, be struck on the top, though occasionally the slightest possible tap may be given to the wedge in order to drive it in a little further, or the iron may be tapped as lightly as possible in order to secure its proper adjustment in bringing the edge parallel with the surface of the sole. The sole of the plane, if the stock be without an iron plate or shoe, should be greased or oiled occasionally. This has the effect of preserving the stock and causing it to move more easily over the surface of the wood that is being planed.

Removal of plane-iron.

Adjustment of iron.

Sole of plane: its use.

390. The following remarks on the use of the plane are made in "The Amateur Mechanic's Workshop," and they are quoted here because if an amateur will carefully attend to them, he will be enabled to overcome most of the hindrances he has hitherto experienced to performing the operation of planing with ease and facility. "Much of the difficulty," says the writer, "which amateurs experience in using the plane arises from the latter being *badly set for work.* If either corner projects beyond the general level of the sole of the plane, this will necessarily score grooves or channels. Hence the extreme angle should be slightly rounded off in sharpening the tool. The same deleterious effect will be produced if the plane-iron is not ground truly square, and hence the caution already given on that point. The smaller, or break-iron, whose office is to bend up the shaving somewhat sharply so as to ensure the cutting of the other iron, and to prevent its splitting off the surface of the work, should be placed so

Difficulty in planing: how caused.

Proper positions of break-iron and cutter.

as to come within one-eighth of an inch of the extreme edge of the cutter for rough work, and within one-twentieth for finer or finishing work. The two should then be placed in position so that the edge project the smallest possible degree below the sole. The position can only be determined by looking carefully along the bottom of the plane, with the front of the same next to the eye, as in fig. 157. The edge will, if correctly formed and placed, appear quite parallel with the sole. It is then ready for use. The same rule applies to the small as to the large planes, except that in the jack-plane the iron projects rather more, as it is used for roughing down a surface. The trying-plane, which is longer, and intended for edging boards which are to be joined lengthwise, is always very finely set, and the mouth is narrow. The break-iron is also set very close down to the cutting edge. The longer the plane the more accurately level and true will be the work done by it. As it will be useless for the amateur to attempt the construction of any work, except of the roughest character, until he can plane a piece of board accurately on all sides, keeping the edges square and sharp, the greatest attention should be given to the use of this tool."

Mode of looking at adjustment.

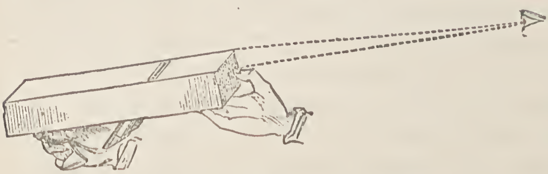


FIG. 157. ADJUSTMENT OF PLANE IRON.

391. It has been said that the planes which the amateur artisan most requires are the jack-plane and the smoothing-plane. With these he can do all ordinary work, but for rebating, grooving and tonguing, ploughing grooves, and other operations of a similar character, he requires planes of a different construction, such as the rebate-plane, match-plane, and plough. The principle and general construction of these planes have already been described. It is with the mode of using them that we are concerned.

Planes for rebating, etc.

392. For rebating, or cutting a rebate, or rabbet, along the edge of a board, that is to say, to take away a portion of the upper edge, rectangular in section, so that the lower edge projects beyond the upper part of the board, like one step below another, a rebate-plane is required. Indeed it is necessary to have two of these planes, one having the iron set across the sole at right angles to the length of the plane, for cutting a rebate parallel to, or *with* the grain, and the other with the iron set obliquely across the sole for cutting a rebate at the end of a board *across* the

Rebating: what it is.

Cutting rebate.

grain. To work such planes as these with anything approaching accuracy—or, in other words, to make a rebate parallel to the edge of the board—is a difficulty that is experienced by regular artisans, as well as amateurs, and for this reason—in operations of this kind a plane called the side fillister, or filletster, is used. This plane has a shifting fence at the bottom, secured by two screws which work in slots in the fence, so that the position of the fence may be regulated in accordance with the width of the rabbet, or rebate, to be made. A screw-stop is also placed on the side of the plane farthest from the operator, by means of which the distance to which the plane-iron may enter the wood and clear it away is regulated; and in front of the grooving-iron there is an iron which projects in front of the cutter and slightly below it. This cuts down the vertical side of the rabbet, while the plane-iron carries away the wood horizontally, rendering it impossible with this combination of cutters for any wood to be left in the angle of the rebate.

Side fillister.

393. The "bull-nosed rabbet plane," as shown in fig. 158, is a useful kind of plane for rebating. It is sold, with other planes, illustrations of which are given below, by Messrs. Churchill and Co. This plane is adjustable, is 4 inches long, and has a cutter 1¼ inches wide. The price is 5s. 6d. Extra cutters are supplied with the plane at 1s. each. In speaking of this useful plane the opportunity may be taken to call the attention of the amateur to some useful little planes with which good work can be done, although, as far as size is concerned, they are scarcely beyond the category of toy planes. Figs. 159 and 160 represent two different

Bull-nosed rabbet plane.

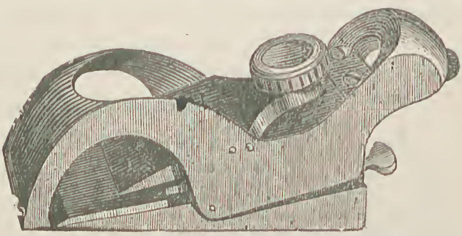


FIG. 158. BULL-NOSED RABBET PLANE.

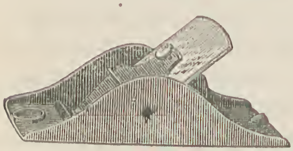


FIG. 159. THE STANLEY SMOOTHING-PLANE.

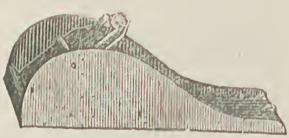


FIG. 160. THE STANLEY BULL-NOSED PLANE.

forms of these planes, which are known as the "Stanley" Iron Planes. Fig 159 is a smoothing-plane, and so is fig. 160, but this, from the

rounded shape of the front is distinguished from the other as a bull-nosed plane. Both kinds are japanned, 3½ inches long, and have 1 inch cutters. They cost no more than 1s. each, and extra cutters may be purchased at the rate of 4½d. each.

"Stanley" iron planes.

394. The rebate plane and the side fillister is generally held with the right hand on the top of the frame behind the iron, and the left hand on the front. The side fillister plane is by no means an expensive tool, as it can be bought at 2s. 6d. or 3s.; but if an amateur has a rebate plane he can easily furnish it with an attachment which will render it to the full as useful as any side fillister that he might purchase. The addition is thus described by Mr. Ellis A. Davidson in "The Amateur House Carpenter," in speaking of the rebate plane. "In using this," he says, "the chief difficulty experienced by the amateur is in making the plane travel in a true parallel to the edge of the board; and there are planes made with guides to accomplish this, but these are very much more expensive, and the following means will answer the purpose quite as well." Supposing X to represent the plane looking at the fore end, or a transverse section of the plane, "let A be a board in the edge of which it is required to cut a rebate ½in. wide and ¼in. deep; a strip of these dimensions has literally to be planed away, and the plane must therefore be prevented travelling horizontally farther on the surface of the board than ½in. and vertically it must not be allowed to sink deeper than ¼in. These planes are made from ¾in. to 2in. wide. We will assume that the one with which the work is to be done is 1½in. wide. Plane up a strip of wood B, fig. 161, to the width of one inch (the thickness will not be any consideration), and screw it at right angles to another piece, C, thus forming a letter L. This will form a case which will, when planed and fastened to the side of the plane by a couple of screws, shut off 1in. of the width of the sole, allowing it to encroach upon the surface of the board to the extent of ½in. only; a mere strip, D, screwed on the other side at ¼in. from the sole, will prevent the plane sinking deeper than is required. On no account should the guide be screwed to the sole of the plane, which should always be kept perfectly smooth, the surface uninjured by screw holes. Nor is it necessary to damage the sides of the plane by more than two small screw holes, for the same side-piece C may be permanently used, the width of the

Mode of handling rebate plane, etc.

Attachment to rebate plane.

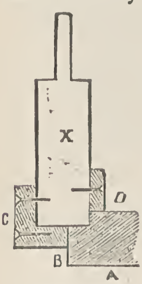


FIG. 161. ATTACHMENT TO RABBET PLANE

strip B being altered according to circumstances; and the width of D can also be regulated, either by planing a portion off below the screws if the rebate is to be deeper, or moving the screws lower down in the the strip if it is to be shallower, taking care that the holes correspond with those in the side of the plane, and that the strips do not cover the apertures through which the shavings should escape."

395. Match planes are bought in pairs, one of the two being so made that the iron cuts a groove or trench lengthwise in the edge of a board; and the other so that the iron cuts away the edge on both sides, after the manner of a double rebate, leaving a projecting rib or tongue, as it is commonly called, in the centre, which fits accurately into the groove that has been cut by the other plane, when the boards are brought together edge to edge. Match planes are so called because the width of the projection left by one plane *matches*, or tallies exactly with, the width of the groove cut by the other. But, as it has been already said, as the amateur can always buy match-boarding ready to his hand, he can do very well without match planes.

Match planes.

Why so called.

396. The plough which is used for cutting grooves in wood at any distance from the edge that may be required, so that it be not beyond the length of the strips, or bars of wood, that are attached to the fence (by which it is guided along the edge of the wood so that the groove cut by the iron may be parallel to it) and pass through the stock of the plane as well as at right angles to it, is held, as shown in fig. 162, by putting the right hand over the top of the plane behind the iron, the first finger along the top by the side of the iron, and the second, third, and fourth fingers round the arm. The left hand is placed by the fence at the side, the thumb on the top of the arm, the first finger extending along the fence, and the remaining fingers closed. The plough is necessary in such work as making drawers, in which the bottom is let into a groove made all round the inner surface of the sides at a little distance from the lower edge. It is fitted with eight irons varying in width from ⅛ inch to ⅝ inch, for making grooves of various sizes. The depth to which the iron should go is regulated by a top screw attached to a plane. The plough or grooving plane, called the old woman's

Plough for cutting grooves.

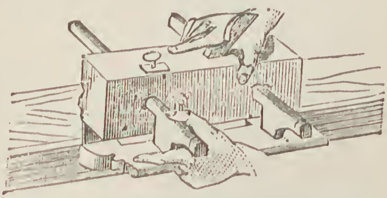


Fig. 162. How to hold the plough.

Old woman's tooth.

tooth, will cut a groove across a board and at any distance from the edge, a desideratum in making pigeon holes in which the vertical partitions are slipped into opposite and corresponding grooves formed one in the lower surface of the horizontal board above, and the other the upper surface of the horizontal board below, of which one forms in the top and the other the bottom of the pigeon hole.

397. There are some useful combination planes made in America, in which the functions performed by the different planes that we have been describing are united. These planes are sold by Messrs. Churchill and Co. That which is represented in fig. 163 is Miller's Combined Plough, Fillister, and Matching-plane, embracing, as it does, in a most ingenious and successful combination, the common carpenter's plough, an adjustable fillister, and a perfect matching-plane. The entire assortment can be kept in smaller space, or made more portable than the ordinary carpenter's plough.

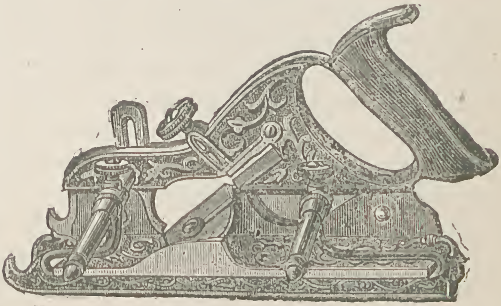


FIG. 163. COMBINED PLOUGH, FILLISTER, AND MATCHING-PLANE.

American Combination planes.

398. With each plough eight bits (⅛, $\frac{3}{16}$, ¼, $\frac{5}{16}$, ⅜, $\frac{7}{16}$, ½, and ⅝in.) are furnished, also a tonguing tool (¼in.), and by the use of the latter, together with the ¼in. plough-bit for grooving, a perfect matching-plane is made. A metallic bed-piece with 1½in. cutter in it can be attached to the stock of the tool by means of two screws passing through the slots in the base piece of the stock. Over this bed-piece the gauge, or fence, will move backward or forward, and when secured to the bars by the thumbscrew will constitute an adjustable filletster of any width required by the owner. The upright gauge on the back of the stock is adjusted by a thumbscrew likewise, and regulates the depth for the use of the filletster, as for all the other tools embraced in the combination. The price of this useful plane with all its various fittings is 36s.

Bits supplied with plane.

399. It may be objected that an amateur will never require and never purchase such a tool as this, and that it is therefore but of little use to mention it here, and the objection, to a certain extent, is a good one; but, on the other hand, amateurs are found who attain

high excellence in the art they have adopted for their amusement, or who have ample means to acquire possession of tools of this kind which may fairly be called tools *de luxe;* and as this book is written for the information of amateurs of all kinds and classes, rich and poor, inexpert and highly skilled, it would be hardly fair to pass them by without mention. We make no further apology, therefore, for mentioning another of these Combination planes—Trant's Adjustable Dado, Filletster, and Plough' which, with some of its fittings, is figured in the accompanying woodcut. The tool here represented in fig. 164 consists of two sections :—a main stock with two bars or arms, and a sliding section, having its bottom or face level with that of the main stock. It can be used as a dado of any required width by inserting the bit into the main stock and bringing the sliding section up to the edge of the bit. The two spurs, one on each section of the plane, will thus be brought exactly in front of the edges of the bit. The gauge on the sliding section will regulate the depth to which the tool will cut. By attaching the guard-plate (A) to the sliding section, the tool may be readily converted into a plough, a filletster, or a matching-plane, as explained in the printed instructions which accompany each plane, but which are too long to be given here. The tool is further accompanied by eight bits ($\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{7}{8}$, and $1\frac{1}{4}$ in.), a filletster cutter (B), and a tonguing tool (C). All these bits are secured in the main stock on a skew. The price of this handy and useful combination plane, consisting of an iron stock and fence, and including

These tools seldom required by amateurs.

Trant's Adjustable Dado, Filletster, and Plough.

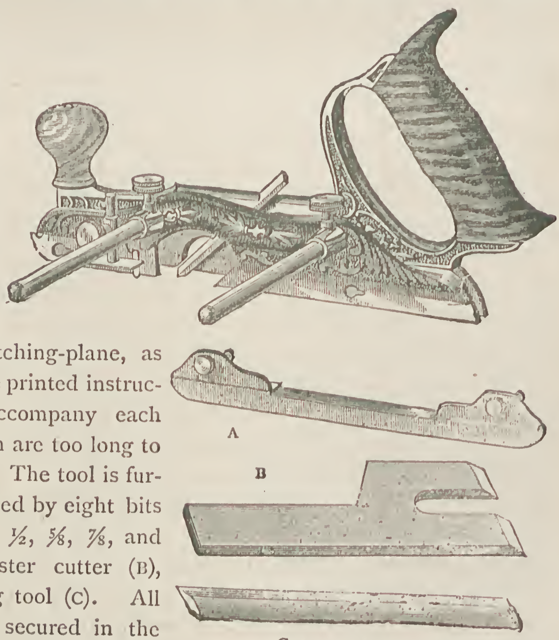


FIG. 164. TRANT'S ADJUSTABLE DADO, FILLETSTER, AND PLOUGH.

guard-plate, plough bits, and tonguing and grooving tools, as enumerated above, is 32s.

Drawing-knife and spokeshave: how to handle them.

400. We have now done with the planes, and must pass on to the drawing-knife and spokeshave, the use of which will be easily understood by referring to figs. 59 and 60. The drawing-knife is held with both hands, one grasping one handle, and the other the other, but in such a way that the bevel of the blade is upwards and the opposite surface resting on the wood to be cut. The spokeshave is handled in the same way, the flat part of the iron shown in the engraving being next to the wood. The bevel of the blade is inwards and cannot be seen. The distance between the wooden handle or stock and the blade of the spokeshave may be increased or diminished by tapping the points of the turned ends of the blade, which pass through the stock. The cutting edge of each of these tools may be sharpened by rubbing them with a slip.

Modes of using chisels and gouges.

401. It is obvious that the modes of using chisels and gouges of the ordinary form cannot be many. In the case of the chisel they are restricted to paring and cutting mortises; the gouge is chiefly used for making grooves, scooping out hollows, as the hold of a model ship, or in cutting mortises, when the tenon is rounded, instead of being perfectly square.

Chisels: their varieties.

402. It has been said that the chisels used in ordinary carpentry and joinery are of three kinds—the firmer chisel, the paring chisel, and the mortising chisel. Of these the mortising chisel can only be used for cutting mortises, and the paring chisel for cutting or paring wood, as the name implies. The firmer chisel, on the contrary, which is shorter and stiffer than the paring chisel and broader than the mortising chisel, can be used equally well for either purpose, although its shortness renders it somewhat less convenient than the longer paring chisel. The firmer chisel, then, is the tool that will be of most service to the amateur, who cannot afford to provide himself with chisels of each description.

Mortise and tenon.

403. It may now be convenient to describe the mortise and tenon, and to show what these terms mean. A mortise is a notch or cavity cut into a piece of timber, or any other material, to receive the end of another piece, called a tenon, which is made to fit it. Thus, in fig. 165, the end of the upright A has two rectangular pieces of equal size cut away, one on one side and one on the other, as at B and C, the blocks or pieces that are cut off being shown by dotted lines. The piece D, that is left in the middle when

the blocks are removed, is called the tenon. The object in view is to attach the upright A to the horizontal piece of wood E by means of the tenon, and to effect this a cavity is cut, as shown at F, of the exact size of the tenon in order to receive it. The tenon is then knocked into the mortise—it should fit tightly, and therefore requires force applied by a striking tool to bring it into its place; and the upright stands immovable, being prevented from leaning or from being forced to one side or the other by the shoulders that are formed on either side of the tenon when the side pieces are cut away. The meaning of the word *tenon* is obvious; it is, "that by which something holds," and the word itself is derived from the French *tenir*, to hold, which in its turn is obtained from the Latin *teneo*, I hold. The meaning of the word *mortise* is not so plain. The French equivalent is *mortaise*, and as the mortise bites or grips the tenon in its open mouth or jaws, so to speak, it is to be traced to the Latin *morsus*, bite, or the hole or place in which the tongue of a buckle, or point of a javelin, knife, or sword enters and sticks fast, from *mordeo*, I bite. Thus Virgil uses the expression *morsus roboris*, the cleft of an oak, to indicate a rift in the tree in which a javelin, thrown by the Trojan hero Æneas, had lodged and stuck fast. The width of the tenon is made to correspond to that of the mortise, and *vice versâ*, by the use of the mortising gauge. We shall return presently to the construction of mortises and tenons in the next chapter, at present we have to consider more especially the mode of using our tools.

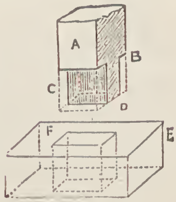


FIG. 165.
MORTISE AND TENON.

Meaning of "tenon."

Meaning of "mortise."

404. In cutting a mortise, the chisel is grasped firmly by the left hand, and held in a nearly upright position, as in fig. 166. The wood is in all cases cut by the chisel across the grain, and the operator must take care to remember that the flat part of the chisel must always be turned towards the end of the mortise, and the bevel towards the middle. Thus in cuting a mortise, the position of the chisel in the hand must be continually changed, the bevel being towards or turned from the operator, according to circumstances. The chisel is of course struck by a mallet held in the right hand. In cutting a mortise there is no necessity to make any cut with the chisel in the direction of the grain, all that need be done is to keep

Chisel in cutting mortise: how it should be held.

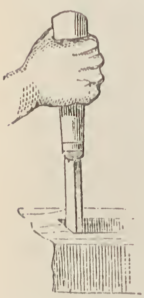


FIG. 166.
CUTTING A MORTISE.

working by cuts at a short distance from each other, *across* the grain, beginning in the centre of the wood to be removed, and proceeding both ways from the centre to either end. It will be found that the wood will come clean out of the cavity without any cutting along the sides of the mortise.

Paring chisels, etc.: how to hold them.

405. In paring, when the end of a piece of wood is being cut perpendicularly, or very nearly so, across the grain, the paring chisel or firmer chisel, whichever the operator may have, should be grasped firmly in the right hand, as shown in fig. 167, the piece of wood that is being cut being held down firmly by the left hand, which must of necessity be placed *behind* the chisel and should be kept well back out of the way, to prevent injury from any slipping of the tool. When paring in the direction of the grain, as in cutting a point to a piece of wood, or in fashioning a wooden pin or wedge, for example, the chisel should be held in the right hand, and the wood in the left hand, in the position and manner shown in fig. 168.

FIG. 167.
HOLDING PARING CHISEL.

The gouge: how to hold it

406. The gouge may be held in the manner indicated in figs. 167 and 168, according to the nature of the work that is being done. Thus in cutting a groove across the grain in the end of a piece of wood, it should be held as in fig. 167; but in cutting a groove or channel in the direction of the grain, or in scooping out the hold of a model or toy boat, it should be held as in fig. 168. In all cases, however, where the gouge has to be struck with the mallet, it must be held like the mortising chisel, as shown in fig. 166. In this way the gouge is sometimes used to prepare an indentation or shallow cavity for the entrance of a shell auger or shell bit, when used in the brace.

FIG. 168.
HOLDING THE PARING CHISEL.

Use of boring tools, etc.

407. There is little to be said about the rest of the tools, for the very nature of each will suggest the manner in which it is to be used; but a few remarks may be useful on the mode of using the various kinds of boring tools, and in addition to these something may be said about the manipulation and method of using the marking and mortising gauges, and the nail punch.

408. In boring holes with the bradawl and gimlet, the chief thing is to take care that the blade enters the wood at right angles to its surface, unless it be necessary to pierce a hole in it at an angle to the surface, as in skew nailing; but for driving in a nail in the usual way, that is at right angles or perpendicularly to the surface of the piece of wood that is being nailed down, the blade of the bradawl or gimlet must enter the wood perpendicularly. Practice alone will make the amateur perfect in doing this. He will often fail at first, very much to his annoyance.

Boring with bradawl and gimlet.

409. In holding the bradawl the thick end of the handle is lodged against the palm of the hand and the ball of the thumb, being retained in that position by the second and third fingers; the first finger is extended along the blade, and the extremity of the thumb rests on the upper end of the handle or on the brass ferule which is fitted over it.

How to hold bradawl.

410. In using the gimlet the cross-piece or crutch handle, into which the blade is inserted, is grasped in the right hand, and held against the palm, the blade of the tool projecting between the first and second fingers, at the first joint of each, reckoning from the knuckles upward toward the tips of the fingers. It is driven into the wood by a series of half turns of the hand from right to left, the handle being released and grasped again at every half turn.

The gimlet: how to hold it.

411. The ends of the crutch handle of an auger are held, one in the right hand and the other in the left, and the tool is turned from right to left, the hands being taken off and replaced on each end of the handle in succession at every half turn of the tool. The hands will, of course, be held in opposite directions, the palms facing inwards and the fingers and thumbs grasping the ends of the handle, as when holding the chisel in mortising. As in the case of bradawls and gimlets, great care must be taken that the blade of the auger enters the wood perpendicularly to the surface; and it assists the entrance of the tool to cut out a small depression, or cavity, for the reception of the end of the auger, especially if it be a shell auger.

The auger: how to hold it.

412. The principles of the brace and bit have been fully explained. It may be held in any position, and a skilled workman will do so, and manage to bore a hole truly perpendicular to the surface with the greatest facility. The amateur, however, should stand upright, or as nearly so as possible, when using the brace and bit, having the part of the wood in which the hole is to be bored just about the height of his chest. The brace and bit may often be used with advantage in cutting a mortise, and a shell

Position when using brace and bit.

auger may also be used for the same purpose. A bit or auger of the width of the mortise should be used, and the work of the chisel is then confined to cutting out the corners and the projections between the holes.

Boring holes with brace and bit.

413. In boring a hole with the bit and brace the round flattish knob is generally placed against the chest, and held tightly against it by the left hand, which grasps the tool directly in front of the knob, the fingers resting on the part which is uppermost. The handle attached to the crank is grasped by the right hand, as shown in fig. 169, and the crank is turned and the bit caused to revolve from right to left. It requires a good deal of practice to use this serviceable tool with ease and readiness; but when the amateur has once overcome the first difficulty of managing it, he will find it to be of the greatest assistance to him in carrying out many operations in carpentry and joinery.

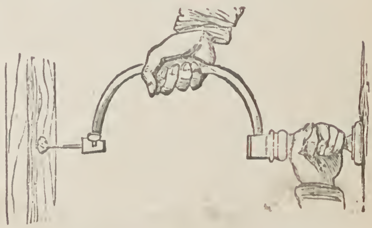


FIG. 169. BORING WITH BRACE & BIT.

Use of mortise gauge.

414. In using the marking gauge for single lines, and the mortising gauge for double lines, straight in both cases and parallel to the edge of the wood on the upper surface of which the marks are made,—the object is to preserve the distance to which the points are set from the head of the gauge, and marking, perhaps, many pieces of wood in the same manner, as, for example, in cutting mortises and tenons. Gauges can be regulated to mark single or double parallel lines, as the case may be, according to the nature of the gauge, whether marking gauge or mortising gauge, at any distance from the edge of the wood less than the length of the handle.

Mortise gauge.

415. The gauge will be brought under notice again in considering the method of cutting mortises and tenons in detail. When the points have been accurately adjusted to the desired distance between themselves and the head, if a mortising gauge be used, the bar or stock of the tool should be grasped with the right hand, as shown in fig. 170, in such a manner that the thumb is pressed against that part of the head nearest the operator, and the forefinger laid over its top and the opposite side. The points should be just long enough to make a

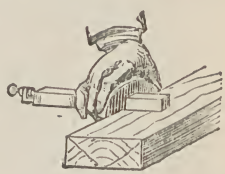


FIG. 170.

slight incision or scratch along the surface of the wood; if they are too long they drag in the wood, and prevent the operator from doing the work quickly and easily.

416. The nail punch is a short bar of iron, thick at one end and tapering to a point at the other. It must be held, as a matter of course, in the left hand. The thick end must be grasped by the thumb and forefinger, as in fig. 171, and steadied in the manner shown by the second and third fingers passed *under* it, and the little finger *over* it. This enables the operator to hold the point of the tool firmly against the nail that is to be driven below the surface of the wood, and prevents it from slipping off. The blows of the hammer should be delivered quickly and smartly.

The nail punch: how to hold it.

FIG. 171. HOLDING NAIL PUNCH.

CHAPTER VII.

VARIOUS METHODS EMPLOYED IN JOINING TIMBER.

Joining pieces of Timber—Operation of Planing—Supposed case—Carpenter's Bench—Placing Timber on Bench—Planing must be in direction of Grain—Adjustment of Planing-iron, if required—Planing to proper thickness—Squaring planed wood—Smoothing with Glass-paper—Cutting Mortise and Tenon—Dimensions of proposed work—Marking out Tenon—Setting Gauge—Cutting with Tenon Saw—Marking out Mortise—Mode of cutting Mortise—Mortise to be cut from both sides—Trying in Tenon—Finishing and Securing—Only one way of making Mortise—Double Tenons—Use of Auger, etc, in making Mortise—Halving and Notching—Method of performing operation—Joint of this kind: why weak—Grating for Bath-room, etc.—Joining Quartering and Scantlings—Junction of timber lengthways—Fishing: how performed—Halving: how done—Securing Joint with Bolts and Plates—Proper length of halved Joint—Scarfing: meaning of term—How performed—Lateral Joints—Four methods used—Rebating: how it is done—Tonguing and Grooving—Hand tightness—Grooving and Slip-feathering—Planing Slip-feathers and Laths—Joining edges of Boards—Dove-tail feather—Dowelling—How performed—Gluing Joints—Difficulty in getting glued joints to hold—Glue should be spread thinly—Joining boards at right angles—Nailing Boards end to end—Making small Frame—Keying: how performed—Corner piecing—Dove-tail joining—Common Dove-tail Joint—Dimensions of Pin and Socket—Method of Marking out—Diagram to be drawn larger for practice—Cutting parts of joint—Compound Dove-tail—Mode of making it—Dove-tailing for Drawer Fronts—Description of this kind of Dove-tailing—Completion of the work—The Mitre Dove-tail—How to make the Mitre Dove-tail—Illustrations helpful in making these joints.

Joining pieces of timber.

417. HAVING provided himself with tools, and having learnt in some measure how to handle them and how to use them, the next thing to which the amateur artisan must turn his attention to is the consideration of the various methods employed in joining timbers and pieces of wood together. But before attempting any of these operations, though they may be said to be operations that are performed every day in Carpentry and Joinery, it is absolutely necessary to be able to saw and plane wood in a tolerably efficient manner—to saw truly and straightly in accordance with the guide lines made by the operator to enable him to make the saw-cut, be it of what kind it may, in the proper direction, and to plane up the surface of a piece of wood and its edges in a workmanlike manner.

418. The operation of planing has been already dwelt on to some

extent, but at the risk even of being wearisome the operation may be described again. One of the first, and perhaps the most frequent of wood-working operations, is that of planing a piece of rough wood down to a certain size and thickness. Indeed, whatever joint the amateur wishes to make, he must first plane the different pieces to the right thickness and shape. Nothing but operations in carpentry, such as framing pieces of timber together, can be done without the aid of this useful tool; in joinery nothing whatever can be done without it.

Operation of planing.

419. For the sake of clearer and easier explanation, let us suppose that a piece of wood is wanted which is square in shape; that is to say, with sides of twelve inches every way, and one inch in thickness. The piece of wood which is to be worked into the following dimensions must be rather larger every way, and should be sawn off from the most convenient piece in the amateur's possession.

Supposed case.

420. Allusion has been made once or twice to the carpenter's bench, a *sine qua non* to every amateur; but this will be described in the following chapter, and instructions given for making this, and the stools or trestles that are so necessary when sawing timber or mortising. The uses of the parts of the bench, of which mention must necessarily be made in the following description of planing, will be readily understood. Having sawn off the piece of timber, lay it on the bench just as it is, in the rough, with one side bearing against the bench stop—a piece of wood fitted tightly to a square hole in the bench, and which can be depressed till it is level with the surface, or raised by a few blows from a hammer until it stands above it at a height sufficient for the purpose required. In this case it may be about ¾ in. above the surface of the bench, and rather more than ¼ in. below the upper surface of the wood that is about to be planed. If it project in the least degree above the surface of the wood to be planed, it will inflict very serious damage on the cutter of the plane. The projection can be adjusted to any height by tapping it with the hammer on the top if too high, and below if not high enough.

Carpenter's bench.

Placing timber on bench.

421. Whenever possible—and it is in ninety-nine cases out of a hundred—the wood must be planed *in the direction of the grain;* it is not only much easier, but a much better surface is obtainable. The bulk of what has to come off must be taken off with the jack-plane. Take hold of the handle with the right hand, put the left on and over the plane, just in front of the

Planing must be in direction of grain.

clearance hole, lay the plane flat on the wood, and push it forwards; bring it back, and again send it forward by firm even strokes, taking *especial care* to keep the plane always parallel to the surface of the wood, and not let the ends drop at the commencement and termination of the stroke. This is a very common fault with beginners, but, unless overcome, the surface will never be flat, or, as mechanics call it, "true." The necessity of guarding against this cannot be too strongly impressed upon the mind of the amateur, because it is much easier to do it properly at the commencement, than to get out of the habit when once acquired.

422. If when the plane is passed over the wood no shaving comes off, take the hammer and tap the planing iron very gently. Tap it in the middle, or one corner will be driven out further than the other. Try again. Ah! you have tapped too hard and driven the cutter out so far that by exerting all your strength you cannot move the plane across the wood at all, or, if you move it at all, it only goes an inch or two and runs in deeper than before. That is what carpenters call "too rough." To remedy this, tap the plane smartly behind; one or two blows will not only bring out the planing-iron, but the wedge also. Put both back and readjust. Whenever it is required to take out the cutter, strike the plane *behind*, and whenever it is required to bring the iron down, tap the iron very gently, as it has been said, or knock the plane gently *in front*. When properly adjusted, the amateur will be able, without any violent exertions, to pass the plane smoothly over the wood, bringing off at each forward stroke clean shavings of even thickness, and the planed surface will be smooth and level.

Adjustment of planing-iron if required.

423. When one side of the wood is planed, take the gauge, set it at 1 inch; put the head against the planed surface, and strike a line along each of the four edges of the board; lay it again on the bench, with the planed side downwards, and plane *nearly* down to the line just struck. Smooth off both sides with the smoothing-plane. It is now the right thickness.

Planing to proper thickness.

424. To square the wood put it in the vice—a flat piece or cheek of wood that may be moved farther from or nearer to the side of the bench by one or two screws—and tighten the screw or screws, but not too tight, lest the pressure injure the finished surface of the board above and below. Plane, or "true up," one side, and, with a square, mark off two lines, twelve inches apart, and at right angles to the side already planed. If the board is very much out of square, cut off most of the superfluous wood with the

Squaring planed wood.

tenon saw and finish with the plane as before. In planing the sides in which the end of the grain appears plane down to the line at one corner first, then plane down the other corner, and the middle. If this precaution is not taken the corners will "spawl" off, and through the amateur's carelessness will present a very ragged and unseemly appearance. If the work is required very smooth, the different surfaces must be well rubbed with a sheet of glass-paper or cloth, which, for convenience, is generally wrapped round a small piece of wood. Such a piece of wood may be two or three inches broad, four or five inches long, and an inch thick, so that it may be easily grasped and held in the hand.

Smoothing with glass-paper

425. If the amateur artisan can get through the work above described in a creditable manner, he will be able to do anything that is required in the way of planing, and we may now turn our attention to other operations. And first, as this is a mode of connecting timbers, without which it is next to impossible to frame them together in a proper manner, before proceeding to other methods of joining timber, let us consider the mode of cutting a mortise and tenon, or making a mortise and tenon joint, the nature of which has already been explained in the last chapter.

Cutting mortise and tenon.

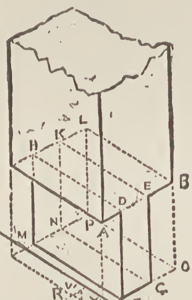


FIG. 172. THE TENON.

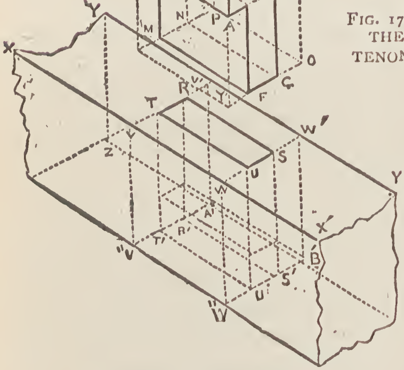


FIG. 173. THE MORTISE.

426. In the annexed engraving, fig. 172 represents an upright with the lower end cut into the form of a tenon; and fig. 173, a piece of wood cut in such a manner that the tenon may fit into the cavity, which is called a mortise. Suppose that the width of each piece of wood is 3in. and the depth 4in.; that is to say, in fig. 172, 3in. from A to B, and 4in. from A to C, and in fig 173, 3in. from X to Y, and 4in. from Y to Z. It is determined in this case not to cut the mortise right through the wood, but to make

Dimensions of proposed work.

the tenon 3in. in length, in which case it will not show itself in the lower surface or bottom of the piece of wood, represented in fig. 173.

427. It is further determined to make the width of the tenon, and therefore, that of the mortise also, 1in., and we must suppose that the wood has been planed up and true on all sides. First of all, a distance of 3in., the depth decided on for the mortise, is measured from the end of the upright, say from F, G upwards to D, E. This distance is marked with the pencil, and by the aid of the square, the straight lines B A, A C, C L, and L B are marked, one on each side or surface presented by the upright. As the width of each piece of wood is 3in., and the tenon is to be in the direction of its depth, that is to say, from A to C or from B to L, and as it is usual to make the tenon just one-third the width, the mortising gauge must be set so that the first point is distant exactly 1in. from the head, and the second, which is the point nearest the end, 2in. from the head. The head of the mortise must be brought first along the edge B O, where the points will mark out the lines E G, D F; then against L P, where the lines K N, H M will be marked; and lastly, against the edge O P, where the lines G N, F M will be marked. The upright, if it be a short one, may be held perpendicularly in the bench-jaw or vice, when the planes H M F D, K N G E will be cut through with the tenon saw. The timber is then laid on the bench, and the tenon saw is passed through the planes C H D A, B E K L, when the rectangular blocks on either side of the tenon will be separated from it, and the tenon be left in a fit condition to be inserted in the mortise when made.

Marking out tenon.

Setting gauge.

Cutting with tenon saw.

428. A distance of 4in. having been measured off with the rule along the line X X′ in fig. 173, at the place where it is determined to cut the mortise, the square is applied to the edge X X′, and the lines V V′ W W′ at right angles to the edge are duly marked off. Then the head of the mortising gauge is applied to the edge Y Y′ or X X′—either will do provided that the timbers are of the same width, which they should be if they have been planed up to gauge—and the lines R S, T U, marked on the upper surface, represented by X X′ Y′ Y. The parallelogram, T R S U, the length of which is with the grain of the wood—a mortise being in ninety-nine cases out of a hundred cut with its length parallel to the grain—shows the place where the mortise is to be cut, and its size, which corresponds exactly with that of the tenon. The wood is then laid on the carpenter's bench, or, if long enough, on a

Marking out mortise.

Mode of cutting mortise.

pair of stools or trestles, and the operator proceeds to cut out the mortise with a mortising chisel or firmer chisel, of the breadth of the mortise—namely, 1in., sinking it gradually to the depth of 3in., or a trifle more, that the shoulders of the tenon may rest on, and fit closely to the upper surface of the wood in which the mortise has been cut; that is to say, the surfaces C H D A, L K E B in fig. 172, on the surfaces V T U W, V′R S W′ respectively in fig. 173. If the wood is long enough to be laid on trestles, the operator sits astride it, and proceeds to cut the mortise, but whether on the bench or on trestles the mode of operation is the same; a notch is first taken out in the middle of the mortise, and the cutting is carried gradually to the end, first in one direction and then in the other, till a depth of about ⅜in. or ½in. has been taken out over the whole of the mortise. When the mortise is to be cut right through the wood, lines should be marked with the square round three sides or faces of the wood (or all four, if preferred), as V′V, V V″, V″A′ and W′W, W W″ and W″B′ and the lines T′U′, R′S′, marked on the under part of the wood. When half the depth of the mortise, or nearly so, has been cut from the parallelogram T R S U, the wood should be turned upside down and the rest of the mortise taken out from the parallelogram T′R′S′U′. By this means the mortise will be carried through in such a manner from side to side of the wood that the upright cannot fail to be perpendicular to it. Had the operator gone on cutting in one direction throughout the whole operation, he might have leant a little to one side or the other, and the other side of the hole would not have been true to gauge. This would have had the effect of throwing the upright piece out of the perpendicular. Whenever an amateur, therefore, is going to cut a mortise right through a piece of wood, he must remember that it will be safer for him to sink the hole from both sides.

Mortise to be cut from both sides.

429. When the mortise is cut try in the tenon, and if too tight to go down to the shoulder without using considerable force, rub some red lead about it and again try it in. The lead will show where the joint binds. Carefully pare off those places thus marked until the mortise is large enough to admit the tenon. When it is brought home to the shoulders, a hole is to be bored through both mortise and tenon with a bit or gimlet, and a wooden pin driven into it. When the mortise and tenon is but small, the joint may be secured by gluing the end of the tenon before it is fitted into the mortise.

Trying in tenon.

Finishing and securing.

430. The method of making a mortise is the same in all cases,

whatever may be its length and width, and but little more remains to be said about this kind of joint. When the wood to be joined is

Only one way of making mortise.

very wide, instead of having one tenon one-third of the width, it is usual to have two tenons, as shown in fig. 174, in the annexed drawing, and consequently two mortise holes. In this case the thick-

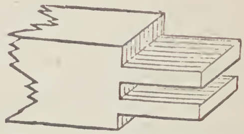


FIG. 174. DOUBLE TENON.

Double tenons.

ness of each tenon is one-fifth the width of the wood. If three tenons are necessary, the thickness of each should be one-seventh of the wood. It is not likely, however, that the amateur will ever find it necessary to proceed beyond a double tenon. The form of tenon shown in fig. 175, is also very useful; it does not weaken the wood so much as the other methods. When a very wide tenon is required, this shape may be used with advantage. It will readily be understood by referring to the illustration.

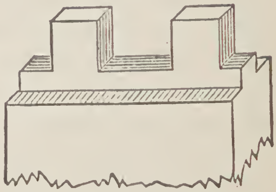


FIG. 175. DOUBLE TENON.

431. It has been said that assistance may be obtained in making mortises from the auger and brace and bit. The manner is shown in

Use of auger, etc., in making mortise.

fig. 176, in which let A B C D represent a mortise 1in. wide and 2½in. long. If two holes be taken out with an inch bit as at E and F, it is clear that all that remains to be done with the chisel is to clear away the corners at A, B, C, D, and the intervening space between E and F, in which case it will be necessary to cut the *sides* A B, C D of the mortise, which is never requisite when the whole of the wood to be removed is taken out with the chisel in the ordinary way.

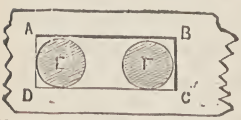


FIG. 176. USE OF AUGER IN MAKING MORTISE.

432. There is a method of connecting timbers by halving and notching which may be described, as it may possibly be of use to the

Halving and notching.

amateur in some cases, especially if he be not very far advanced in the art of carpentry, and not sufficiently skilful to make a mortise and tenon joint. It is a joint that materially weakens the wood, reducing its strength just one-half.

433. Fig. 177 will suffice to show the manner in which timbers may be halved and notched into each other. Suppose that the timbers A and B are two pieces of quartering 2in. square, after being planed

up. The marking gauge is set to 1in. and applied to the timbers, tracing out the lines C D on A, and E F on B, and similar lines on the sides opposite to these, which are hidden from view. Spaces of 2in. are then set off, where the pieces are to be notched into each other, and guide lines drawn with the square round the three sides in which is contained the piece to be notched out, as at G H K, L M N in B. These lines serve to direct the tenon saw, which is passed through the lines H K, M N, till it meets the transverse lines traced by the gauge. A broad chisel and mallet is then called into requisition to remove the notch, the edge of the chisel being in the guide lines traced by the marking gauge, and the handle struck lightly so as to impel the chisel gently into the wood. After this has been done once or twice, first on one side and then on the other, the piece will come away, leaving a hollow as shown in the drawing. Any inequality of surface that may be caused by projection of fibres at the bottom of the notch may be pared away with the chisel. A notch precisely similar to that which has been made in B is made in A; the mode of operation in each case being exactly alike. The two pieces are then fitted one into the other, the notch in each receiving the part that is left in the other after the notch has been made, and the piece which was previously contained in it removed. When fitted together the wood presents the appearance shown at X. A couple of holes should then be made with a large gimlet, and the two pieces be fastened together by wooden pegs. It is better to put one peg in on one side and the other on the side opposite to it, instead of driving in both on one side.

Method of performing operation.

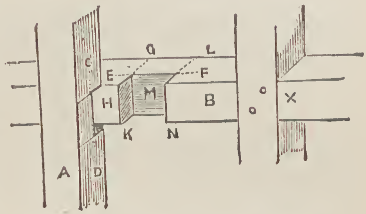


FIG. 177. HALVING AND NOTCHING.

434. It has been said that this is a weak kind of joint, and so it is, on account of the great reduction that is made in the thickness of the wood in both pieces. It is useful, however, in joining cross-pieces, for the pressure of the shoulders of the notches on the surfaces on which they rest gives great rigidity to the joint, so that it is impossible, if the pieces have been accurately cut and let into one another, to move the arms of the cross thus formed in any direction. It is bad when the *end* of one piece of wood is halved into another piece, as in the case of an upright into a horizontal piece, or *vice versâ*, and it is infinitely worse when the

Joint of this kind, why weak.

ends of two pieces of wood are halved for the purpose of joining the pieces themselves at right angles. The case in which halving and notching comes into operation with the best effect is in making a grating, on which to stand in a bath-room or on a stone floor. In this a number of pieces, all lying in one direction, are halved into a number of others at right angles to them, as in fig. 178, the ends on all sides being let into a frame a little thicker and wider than the bars themselves. The bars, when fitted into one another should be fastened with wooden pegs, and the plane passed over the surface to remove any inequalities that may remain after the heads have been cut off with the saw or chisel. Inch square bars make a substantial and useful grating of this kind, the notches being made at a distance varying from 1in. to 1½in. apart.

Grating for bath-room, etc.

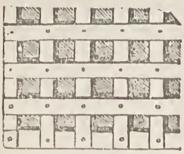


FIG. 178. GRATING.

435. We have now considered the methods of joining such pieces of wood as quartering and scantling, and smaller pieces that assume the form of bars, at right angles to each other. It is now necessary to see how such pieces of wood may be joined *longitudinally* or lengthwise, end to end, so that each piece is in direct continuation of the other, in one and the same straight line; and then to consider the methods that are adopted for joining boards on pieces of wood *laterally* or side by side, so as to present a uniform and level surface, and *at an angle*, most commonly a right angle, as in the case of a drawer or box.

Joining, quartering, and scantlings.

436. The modes of joining timbers longitudinally, or end to end, are three in number, and may be described as *fishing*, *halving*, and *scarfing*—beginning with the most simple manner of effecting a joint in this direction, namely that of *length*, and proceeding onwards to the most difficult.

Junction of timber lengthways.

437. Fishing is a mode much used at sea for strengthening a mast, yard, or spar, that has been sprung or cracked but not broken in half. It is an operation very similar to that performed by the fly-fisherman when a joint of his fishing-rod is cracked in the manner shown in the annexed engraving, fig. 179; and he repairs it by winding a piece of waxed silk over the fracture, as shown in fig. 180. An exemplification of this fish-joint or fish-plating is to be seen on any railway, for this is the manner in which the ends of the rails are connected, as shown in fig. 181. When the sailor fishes a spar, instead of using rope only, as is done with silk or fine cord in splicing the broken joint of a fishing-rod or a walking stick, he lays some short

Fishing: how performed.

pieces of timber lengthwise along the spar, and binds the rope over them, the longitudinal timbers helping to support and keep in place the ends of the fracture, and preventing increased injury from any additional strain that may be made at any time on the upper or riven part of the spar. The timbers act in fact in a manner similar to the plates at the junction of the ends of two rails on a railway as in fig. 181. The amateur may connect timbers in this way by abutting the ends one against the other, and laying iron plates one on each side of the joint, bolting the whole together with bolts and nuts, as shown in fig. 182.

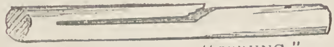


FIG. 179. TIMBER "SPRUNG."

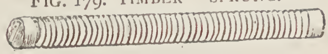


FIG. 180. MODE OF FISHING.

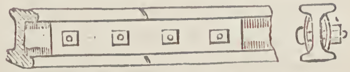


FIG. 181. JUNCTION OF RAILS ON RAILWAY.

FIG. 182. JOINING TIMBERS WITH PLATES AND BOLTS.

438. *Halving* is the simplest mode of performing the operation to which the general term "scarfing" is applied; but instead of including it under this common name, it is better to apply it to that mode of juncture in which the timbers are cut so as to overlap each other in a direction *parallel* to the surface of the wood, or, more correctly, parallel to two of its sides, and vertical to the other two; retaining the term scarfing for those joints in which the timbers are cut so as to overlap each other, in a direction *at an angle* to two of its opposite sides. The annexed illustrations shows clearly the manner in which halving is performed. The joint may be made so that the plates may be at top and bottom, as in fig. 183, or at the sides; but the overlapping of the timbers from A to B must always be *parallel* to the plates, and never covered by them, for reasons which are so clear that they need no explanation. The illustrations are shown in section, in order to present the course of the bolts in one and the screws in the other.

Halving: how done.

Securing joint with bolts and plates.

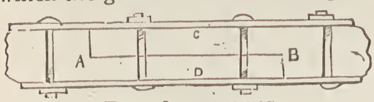


FIG. 183. HALVING.

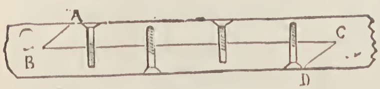


FIG. 184. SCARFING.

439. In halving timbers in this way, the length to which each end should be rebated should be five or six times its depth; that is to say, if the depth or thickness of the wood from C to D be 3in., the length of the rebate from A to B should be from 15in. to 18in. When the

depth of the timbers to be halved together does not exceed 3in., plates may be dispensed with, and screws only used as shown in fig. 184.

Proper length of halved joint.

It is a good plan to cut each overlapping end at an angle, as at A B C, B C D, as the end is then held down and prevented from springing outwards by the projecting tongue with which each extremity is fitted. In all cases of making a halved joint of this kind, it is better that the line of juncture (A B in fig. 183, and B C in fig. 184) should show at the upper and lower surface of the timbers when joined, unless there be a bearing in the centre of the joint, or the distance between bearings on either side be but short.

Scarfing: meaning of term.

440. The term "scarf" comes to us from the German *scharben*, to notch or indent, or from the Swedish *skarf*, a seam or joint, and *skarfva*, to join together. The ordinary modes of scarfing are shown in the annexed illustration, in which fig. 185 shows the simplest kind of scarf joint that can be made. This scarf is used for joining a fishing-rod or walking-stick when either has been broken in half instead of being merely cracked or sprung. The ends of the pieces are carefully pared down at a long slope until they

How performed.

can be fitted together as in fig. 185, the end of one piece laying upon and along the end of the other. The splice is completed by binding waxed silk or thin strong cord over and beyond the lapping ends on either side, from C to D. But to return to the scarfing of timbers, the line of connection from A to B is at an angle to the sides of the connected timbers. In fig. 185 the line of junction A B forms a straight line from A to B. In figs. 186 and 187 it does not, the extremities of the timbers being cut in the form of a step—the upper timber in fig. 187, or that which appears to be uppermost in the section presented to the eye of the observer, being in the line A C D B, and the lower in the line B E F A. In fig. 186 a groove is cut in the face of each timber as at C D, and into this groove a taper wedge is driven which has the effect of locking the shoulders A B into the angles cut for their reception. In fig. 187 this wedge (which must taper slightly in either case) bears against the surfaces C D and E F, and draws the ends of the pieces thus connected well together, forcing, as in fig. 186, the extremities A and B into the angles cut to receive them.

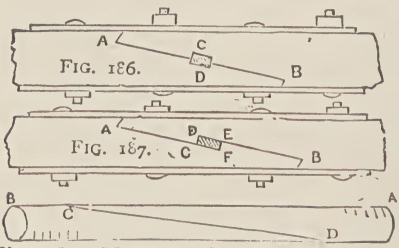


FIG. 185. MODES OF SCARFING TIMBERS.

441. We must now proceed to the method of forming *lateral* joints, which are used in connecting the *edges* of boards together. We have hitherto been dealing chiefly with the ends of timbers, showing how to fit end to end, or the end of a vertical timber into a horizontal timber or *vice versa.* The modes that are ordinarily adopted for this juncture of pieces of wood are four in number, and are known respectively as *rebating, tonguing and grooving, grooving and slip-feathering,* and *dove-tail grooving and feathering.* These methods of joining boards edge to edge must be resorted to, when a surface of wood is required, larger than can be conveniently obtained in one piece. Each method has particular application, and no *one* method will be found to answer for all objects. The purpose for which the work is required, and the material of which it is composed, must be taken into consideration, and the amateur must decide for himself which method may be most advantageously used.

Lateral joints.

Four methods used.

442. The simplest method of joining the edges of boards is by *rebating,* as shown in fig. 188. The means by which this is done has already been explained in describing planes and the various ways in which they are used. In making a rebate-joint all that it is now necessary to say is that the edges of both boards must be planed true, and half of both pieces cut away in such a manner and to such an extent as to overlap each other and join with nicety; the step or half cut from one being filled up by the half or projecting part left in the other. An exemplification of a convenient use of the rebate-joint in carpentry is found in the joining of floor boards, when it is desired to put them down in such a way that no heads of nails are visible. The lower board A is laid first on the joists, and fastened down to them by floor-brads driven in at an angle as at B, the heads being buried in the wood by aid of the brad-punch. The board C is then laid down so that the rebate in it fits over the rebate in A, and the overlap is then fastened down by wooden pegs driven into and through both laps along each joint, as shown at D.

Rebating: how it is done.

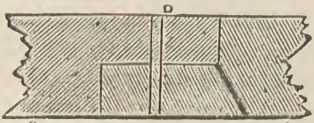


Fig. 188. Rebating.

443. The next method of joining edges of boards, which presents no very great difficulty if the amateur possess a tonguing and grooving plane, or a pair of match planes, is shown in fig. 189. It is called *tonguing and grooving.* After the edges of the boards to be joined have been planed true, a groove one-third of their

Tonguing and grooving.

thickness, and sometimes a little less, is cut in one piece by means of the grooving iron, while by the aid of the tonguing iron a corresponding tongue is cut in the other. This tongue should fit the groove some-

Hand-tightness.

what tightly, indeed, in the manner called by joiners "hand-tight," meaning so tight that it cannot readily be pulled out with the hand. At the same time care must be taken that the tongue is not so large and fits so tight that it will burst the groove. An exemplification of this mode of joining boards is to be found in match-boarding. It is most useful when a large surface has to be covered with boards, and it is necessary to connect their edges in such a manner that the edge of one may hold down and retain in its place the edge of that which has been placed in position just before it.

Fig. 189. Tonguing and grooving.

444. A third method of joining the edges of boards is that of *grooving and slip-feathering*, as shown in fig. 190. As in all other modes

Grooving and slip-feathering.

of joining boards laterally, the edges must be planed perfectly straight and true. A groove, which must never be more than one-third the thickness of the boards to be joined, and which is generally less, is then cut in the middle of both edges. This must be done with a grooving-plane or plough. Amateurs have been told that they can cut out grooves for this kind of joint with a chisel, but they may be sure that, although at the cost of much time and trouble, they may accomplish the necessary twofold groove in two pieces of board for a few inches, they will find it most difficult, if not almost impracticable, to carry it on for any length, and the work when done will not answer their expectations. The planing of the slip-feather that is to be pressed into the grooves to hold the boards together must then be accomplished, and when it is ready it should be coated with glue, and then inserted into the grooves; the edges of the board being brought into close proximity by means of a clamp, or pair of clamps, and held tightly together till the glue is dry.

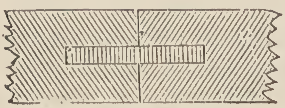


Fig. 190. Grooving and slip-feathering.

445. Whenever the amateur artisan has occasion to plane down a long slip-feather, or anything long and slender, and consequently weak,

Planing slip-feathers and laths.

instead of placing the wood against the bench stop, and planing towards it—in which position the first stroke of the plane would snap the wood—he should nail, or otherwise fasten, the extremity of the slip that is nearest to him, to the

bench, and plane *from* it. Whatever may be the length, it will then be easily accomplished. The amateur artisan should adopt this plan in planing any piece of thin, narrow wood, as laths for trellis-work.

446. The method of jointing edges of boards, which is shown in fig. 191, is called *dove-tail grooving*. The edges are first to be planed true and straight. A groove called a dove-tail groove, from its fancied resemblance to the extended tail feathers of a dove or pigeon, is cut in the edge of each piece. A dove-tail feather is then made to fit these grooves in such a manner, that the effect of putting the feather in its place, which, of course, must be done endwise, will be to draw the two pieces closer together. Cutting the grooves and planing the feather is an operation of great nicety, and one which in all probability will never be performed by an amateur artisan. It is useful in bringing together the edges of two or more pieces of wood intended to form such an article as a drawing board. The straight-sided groove and slip-feather is useful in fitting boards together to form the top of a table, although for this purpose the tongue and groove may be, and is, frequently used.

Jointing edges of boards.

Dove-tail feather.

FIG. 191. DOVE-TAIL JOINTING.

447. A description of the methods used for joining the edges of boards together laterally would not be complete without some mention of *dowelling*, the term applied to the fastening together of boards by means of wooden or metal pegs. It is the method used by the cooper for bringing together the edges of the pieces of wood of which the head and bottom of the cask are formed. The amateur will find it useful in many ways. An exemplification of it may be found in the joining of the leaves of a dining-table, which is regulated by small wooden pegs which project from the edge of one leaf at right angles to the surface of the edge, and fit with great accuracy and nicety into holes made for their reception in the edge of the leaf that is placed next to the first leaf, and so on. In joining wood together in this way, the pieces must be laid side by side so that the edges present one surface, being brought on a level one with the other; and straight lines marked across both edges with a square and pencil to indicate where the pegs are to come. The exact points where the gimlet is to enter the wood in preparing the holes for the pegs, are shown by tracing a line along the edge with a marking gauge. Holes must then be bored along the edge of each board, as shown in section in the accompanying illustration. In A, in fig. 192, pegs of tough wood,

Dowelling: how performed.

which have been previously prepared for the purpose, are driven into the holes to the depth of about 1in. or 1½in., projecting beyond the edge for about the same distance. The points of the pegs are then brought to the mouths of the holes in B, and the board A is driven or brought by pressure towards the board B until their edges are brought close together. The pegs should be glued before being driven into the holes prepared for their reception in both A and B. The operation requires some degree of nicety in making the holes in the edges of the boards exactly opposite each other, so that no undue strain may be made on the pegs. Dowels and dowel pins may be round or square,

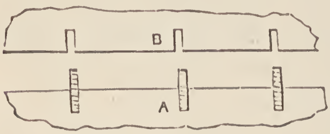


FIG. 192. DOWELLING.

as may be most convenient ; thus it is usual to make round holes and use round pins in working in wood, and square holes in masonry. When a wooden upright is let into stone to keep it in position, a square dowel is cut in the stone, less in every way than the dimensions of the wood, and the end of the wood is then cut to enter the dowel, presenting very much the appearance of a very short tenon. It is manifest that the upright cannot be moved out of its place unless great force be used to it, because the projecting piece in the dowel prevents its motion in any direction.

Gluing joints.

448. In all operations of the kinds described above, the joints should be glued and held together till dry, but no gluing is required in putting down rebated flooring, or in lining the sides of a room, etc., etc., with match-boarding. The method of making glue has been described (see p. 131), and a few words on the method to be adopted in using glue may not be out of place here.

Difficulty in getting glued joints to hold.

449. Some difficulty may be experienced in getting the glued joints to hold. A thin, even coat should be laid on the parts to be joined together with a brush, the several pieces put in their places, and when practicable rubbed together two or three times to insure the even distribution of the glue, and to expel the air from the joints. The whole, as it has been frequently said, must be held together with a clamp until thoroughly dry. In gluing together soft wood, a piece of good chalk should be rubbed over the joints before the glue is laid on. Care, however, must be taken that no knobs or gritty particles be allowed to remain. Not only most amateurs, but many thoughtless workmen also, seem imbued with the notion that the more glue is laid over the wood the stronger will be the joint. This is a great mistake, for a thick layer of glue makes

a weak joint. Indeed, the thinner, in reason, the glue, the stronger will be the joint, the great desideratum being the exclusion of the air. If the air could be *entirely* expelled from between two surfaces, they would adhere one to the other without any glue. In the manufacture of a certain sort of glass, where one piece is ground against another to bring them to a *face*, it is sometimes the case that the air is so perfectly excluded that the two plates adhere to each other so firmly that they cannot be separated without fracture.

Glue should be spread thinly.

450. We must now proceed to a consideration of the methods adopted for joining boards at right angles so as to form a corner. There are two modes of doing this, which are called *keying* and *dove-tailing*. There is another way of connecting boards at right angles which shall be explained, first of all, because it may be useful to the amateur; but the methods just named are by far the best, and those most commonly used—namely, keying in small cabinet-making and light joinery, and dovetailing in all operations in which strength and durability are desirable.

Joining boards at right angles.

451. The third method to which allusion has been made, and which may be described first, is that which is commonly adopted for nailing together packing cases In fig. 193 is shown the way in which this is done. The edge of one board is brought against the inner surface of another, as at A, and nails are driven through the former into the latter to fasten the boards together. The joint is a weak one, and a very little force will serve to disconnect boards; but when four boards are nailed together in this way, as the four sides of a box or packing-case, one corner strengthens another, and they all afford each other mutual support; and when the bottom is nailed on, it is difficult to wrench the boards asunder. When wood of some thickness is used, as in making a small frame to be covered with a light for the reception of plants, etc., a shallow rebate may be cut at each end of the sides, as at B, affording a slight shoulder against which the boards, which form the top and bottom of the frame, can be lodged previous to nailing the whole together.

Nailing boards end to end.

FIG. 193. JOINING BOARDS END TO END.

Making small frame.

452. One of the most useful and most frequently required joints in joinery, is that which is used to unite two pieces of wood to each other at right angles, generally speaking. For very light work, and where strength is of secondary importance, the

Keying.

method shown in fig. 194, and termed "keying" or "keying together" is generally used. The edges, as may be seen, are bevelled or mitred away each to half the required angle of the whole. Thus in a joint at right angles, the line A B would make an angle of 45° with the lines A C and A D, or the surface of the bevel as shown by the line A B would be at an angle of 45° with the outer surface of each of the boards thus joined. If the sides were those of a hexagon, the angle which the bevel would make with the outer surface would be 30°. Glue the bevelled edges together, and when dry make three or four saw cuts diagonally across the joint, half of the cuts or *kerfs*, as they are sometimes termed, inclining upwards, as at E and F, and half downwards, as at G and A. Cut out some thin pieces of wood of such a thickness that they may fit into these saw cuts tightly, dip them in glue, hammer them into place, and when dry cut them off to the shape of the outside of the joint. If done well this makes a very neat joint, the saw cuts being hardly observable, but if the amateur cannot manage it exactly, or if he does not wish anything to show on the outside, he should use the description of joint shown in fig. 195, which is called "corner-piecing." In this the edges are bevelled together in the same manner as in the last, but when glued together, instead of using slips of wood inserted into saw cuts to keep them together, a corner-piece is made and glued on inside. This joint is very simple and neat, but it is not very strong; it is often used for the corners of workboxes and articles required for a like purpose. In such case, the corner-pieces, if not carried upwards the whole length of the joint, but cut off at a height equal to the depth of the tray, will serve as supports for the tray; otherwise ledges to hold the tray must be glued to the sides within.

How performed.

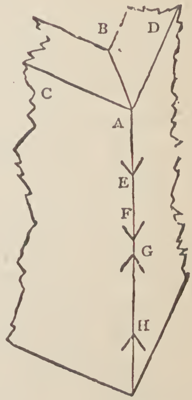


FIG. 194. KEYING.

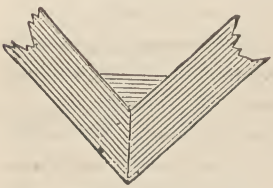


FIG. 195. CORNER-PIECING.

Corner-piecing.

453. Lastly, we come to the dove-tail joint. Of this joint there are four kinds: the common or single dove-tail, the compound dove-tail, the dove-tail for drawer fronts, and the mitre dove-tail. Although it will be necessary to mention the peculiarities of all these in turn, it is needless to do more than describe the construction

Dove-tail jointing.

of the single or common dove-tail in detail, for one and the same principle of construction characterises the whole set, and is used in them all.

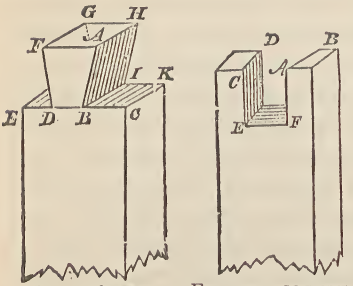


FIG. 196. PIN. FIG. 197. SOCKET.
SINGLE DOVE-TAIL JOINT.

454. When appearance is of little consequence and strength of the utmost importance, the common dove-tail joint should be used. In the annexed illustration, fig. 196 shows the pin, as it is called, and fig. 197 the socket of a single dove-tail. Very few workmen follow any arbitrary rule as to the proportions and shape of the different parts; they go by their judgment and their eye, and if they have had any experience they are seldom wrong. To the amateur, who cannot be expected to have had much if any practice, the following hints will be of material assistance. If he goes according to rule when he commences, practice will soon make him familiar with the proportions, and render any measurement or rule unnecessary. This does not of course do away with the necessity that exists for marking the depth of the pin and socket with the marking-gauge. This must be done even by the best of workmen. Hard and tough wood will admit of an acuter angle than soft wood, or wood that is subject to split or chip.

Common dove-tail joint.

455. Let us take the pin and socket shown in the above illustration as an example. It is, as it has been said, the pin and socket of a single dove-tail, but the same rule is followed in the construction of all. Having determined the depth of the pin, which will be governed by the thickness of the board in which the socket is to be cut, into which the pin is to be fitted, set the head of the marking-gauge to the required distance from the point; and, holding it against the end of the wood, mark on its four sides in succession the lines E C, C K (fig. 196), and the lines opposite to them from E and K on the sides that are not shown in the drawing. Next divide E C into three equal parts in the points D and B, D B being the central third, that is, the root or bottom of the pin. Draw two lines, B A and D F, at an angle of 70° or 80° to C B and E D, respectively. Draw two other straight lines, A H, F G, at right angles to F A. Perform the same operation on the side of the wood that is hidden from view; that is to say, trisect the line from K to the corner formed by the meeting of the lines K and E, and join the points on either side of the central third, to G and H respectively, one of these being H I, which

Dimensions of pin and socket.

Method of marking out.

is shown in the diagram. The reader will find it good practice to copy the diagram on a larger scale, completing the parts cut away on each side of the pin with dotted lines. This will materially assist him when he is putting the directions given into practice on wood. The operator, supposing that these lines have been marked on a piece of wood, must now lay the tenon-saw upon the line C K, and cut across the grain till it comes to B I. Lay the saw next upon A H, and saw in a direction very nearly corresponding to that of the grain until B I has been reached, as before, and a junction is effected with the saw-cut first made through C K. Remove the piece of wood thus detached, and proceed in the same manner on the other side. If a smooth cut be made, nothing further is required to be done to the pin; but if roughly sawn, or the two saw cuts do not meet, and the piece nearly cut off is torn away, the projections that still require to be removed must be cut away with a broad chisel.

Diagram to be drawn larger for practice.

Having finished the pin, it now remains to cut the socket for its reception. First lay the pin upon the *end* of the piece intended for the socket, that is to say, on the end shown uppermost in fig. 197, and with a sharp pencil mark on the end the shape of the pin. The lines thus marked would be those shown as A B and C D in fig. 197, the part between A and C receiving the narrow part or throat of the pin, and that between D and B the wide end, namely, the parts lettered D B and A F in fig. 196. Saw down to the required depth, shown by the line E F. This depth is equal to the thickness of the wood from C to K in fig. 196, and straight lines all round the wood should have been previously marked at this depth with the square. When the saw cuts have been made through A B and C D to the necessary depth, the central piece must be removed with a chisel. The piece removed, if it could be taken away without breaking it, should be exactly the shape of, and *slightly smaller* than, the pin, because the pin has to replace it, and it is necessary that the pin should fit fairly tight into the opening cut for its reception. When glued together, the pin and socket present an appearance similar to that in fig. 198, in which the single dove-tail is represented in a finished state.

Cutting parts of joints.

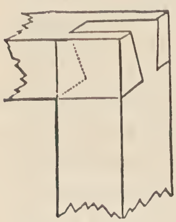


FIG. 198. SINGLE DOVE-TAIL COMPLETE.

456. The compound dove-tail is represented in the annexed diagrams, and the only difference between this and the single dove-tail is, that the first has but one pin and this has three, and may have more if it be necessary.

Compound dove-tail.

Mode of marking it.

457. When the wood has been planed to the proper size, and the sides or edges squared, a line should be struck by means of the marking-gauge along the pin part on both sides from A to B, as in fig. 199. The distance of this line from the edge should be rather more than the thickness of the socket part as shown in fig. 200, which, with fig. 199, represents, the former the elevation of end of the socket piece, and the latter the elevation of side of pin piece. The pins are cut out as in the single dove-tail, the parts at *c*, *d*, being removed by aid of a chisel, while those at *a*, *b*, may be cut out with a tenon-saw or chisel as may be preferred. Lines are then marked on the flat side of the socket part, as shown at C in fig. 200, the thickness of the pin being their distance from the edge of the board. The shape and position of the sockets can easily be found by laying the pins upon the edge of the socket and marking them off with a sharp pencil. The sockets are cut out in the same manner as in a single dove-tail. If the spaces to be removed are at all large, a few steady blows should be given with a mallet upon the chisel handle. The chisel should not be urged to take out the whole of the space at one cut, but a part should be taken at a time, and when the wood is nearly removed the chisel should be held rather out of the perpendicular, so as to cut in under, which will insure a tight and neat joint when put together. The appearance of the pins of the compound dove-tail represented in isometrical perspective after completion are shown in fig. 201, and the sockets in a similar manner in fig. 202. When put together the dove-tail joint appears as shown in fig. 203. In this joint each side shows portions of the end grain of its neighbour. For drawers and such-like articles

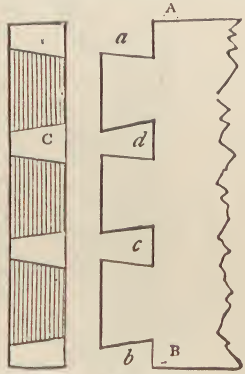


FIG. 200. SOCKET PIECE. FIG. 199. PIN PIECE.
COMPOUND DOVE-TAIL JOINT.

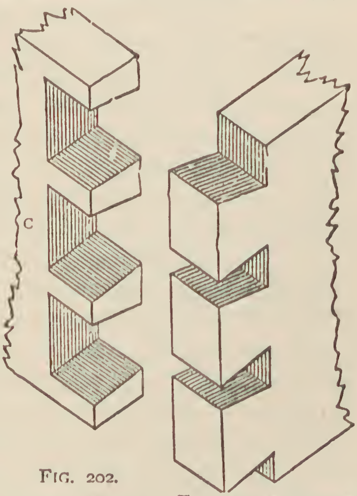


FIG. 202. SOCKET PIECE. FIG. 201. PIN PIECE.
COMPOUND DOVE-TAIL IN ISOMETRICAL PERSPECTIVE.

this, however well done, would look very unsightly ; it is therefore seldom used for those purposes, unless the outsides are veneered, or covered with a thin sheet of some ornamental wood. Should it at any time be used for a drawer, the part marked C must be the front. The reason readily appears from an examination of the shape of the parts composing the dove-tail. Supposing, for the sake of explanation, that the joint was not glued, and that it did not fit very tightly. If the part marked A were used as the front, it would be possible to pull the pins *a*, *b*, *c*, out of their sockets, as there is nothing to prevent their coming out ; but if ever so much force were used to draw C away from A, it could not be done, because the broad parts of the pins *d*, *e*, could not possibly be pulled out through the narrow openings *f*, *g*.

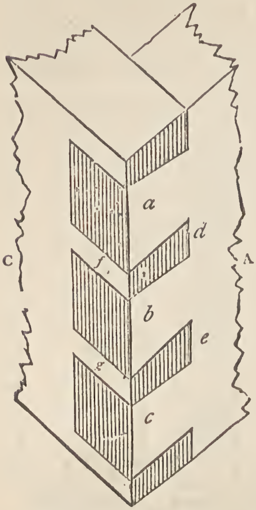


FIG. 203. COMPOUND DOVE-TAIL COMPLETE.

Dove-tailing for drawer fronts.

458. There is a method of making the dove-tail joint for drawer fronts by which the end grain of the side is kept concealed from view, and this does away with any necessity for veneering in order to hide the joint. This mode of making the joints between sides and front is adopted for drawers that are to be painted or stained and varnished, and may be used with advantage in drawers that are to be veneered with mahogany, rosewood, or any fancy wood.

Description of this kind of dove-tailing.

459. The elevation of the end of the front and surface of the side in this kind of dove-tail joint for drawer fronts is shown in figs. 204 and 205 in the annexed illustrations, and the appearance of the pieces when cut in readiness for joining together is shown in figs. 206 and 207, and that of the pieces after they have been joined in fig. 208. The part used for the front is marked F in all the illustrations. It will be seen by referring to the complete joint in fig. 208 that the end grain of the side does not come through, and consequently is not seen. This joint is rather more difficult to make than the one that was last described, but the difficulty of construction is confined entirely to the front part, the side being cut in a manner exactly similar to the ordinary dove-tail joint. When the amateur artisan has occasion to make this joint, he should (after the several parts are trued up and sized with the plane) first cut out the side, as in

fig. 204. The thickness of the side-piece should be rather less than the thickness of the front. When the side is completed it should be laid in position on the end of the front and the shape of the pins marked with a sharp pencil. The sockets which are shaded in fig. 205 must then be carefully cut away with a mallet and chisel. The different parts of this joint should fit each other well, and, indeed, so should the

Completion of the work.

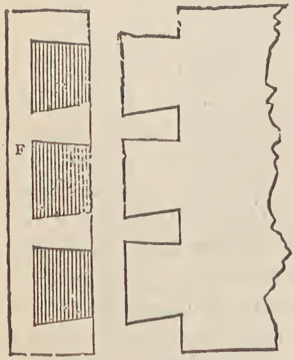


FIG. 205. END OF FRONT. FIG. 204. SIDE.
ELEVATION OF HIDDEN DOVE-TAIL.

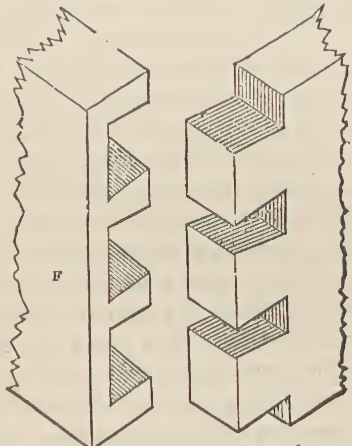


FIG. 207. END OF FRONT. FIG. 206. SIDE.
HIDDEN DOVE-TAIL IN ISOMETRICAL PERSPECTIVE.

parts of all other joints made in wood; but, as in this case, a great deal of strain is thrown on the joints of the drawer in pulling it out, unless they are well fitted together the front will soon become very shaky. The method of making this kind of dove-tail joint is shown clearly in the illustrations, and any further explanation will be needless, as the diagrams speak, as it were, for themselves.

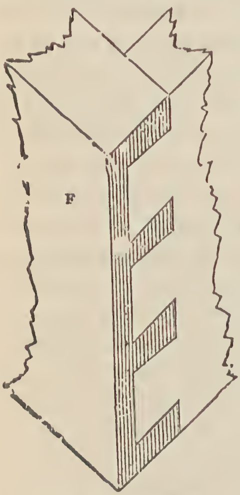


FIG. 208. HIDDEN DOVE-TAIL COMPLETE.

460. The last joint of this description that has to be considered is the mitre dove-tail, which is a combination of keying and dove-tailing. It is a very neat and moderately strong dove-tail; there are no end grains showing, and if done well the joint itself cannot be noticed. It is used, in short, when both strength and neatness are required, which, with the amateur, is frequently the case.

The mitre dove-tail.

461. The first thing to be done in making this joint is to cut the mitre or bevel. For the sake of making the explanation a little clearer, let us suppose that the pieces of wood to be united are of equal thickness, and let fig. 209 represent a horizontal section of the front, and fig. 210 a horizontal section of the side; or, what is the same thing, let the figures in each case represent the upper edge of the boards. Each board must be cut so that the edges marked A in each must meet. In each take the distance A B equal to A C, the thickness of the board, and with the square draw the straight line B H, and join the diagonal A H. Along A C and A B measure equal lines, A K, A E, and through E draw the line E D F with the square, and through K the line K D G parallel to the edge A B or C H. Let this be done on the lower edge of the board as well, and with square or marking-gauge trace a line from F, along the inner surface, along the whole depth of the side, from upper edge to lower edge. Lay the tenon-saw along this line, if it is not too long, in which case it must be cut with the chisel, and cut into the wood until D is reached. Then with a sharp chisel cut away the wood along the part A D of the diagonal A H, removing entirely the shaded part in each board, namely, A D F C. The sockets will now have to be cut in the part G D F H, in fig. 209, and the pins in the part similarly lettered in fig. 210. The great thing in making this joint is to make the bevelled part, A D E, in each precisely similar. If the side is of less thickness than the front, the bevel A D must be cut in the same manner, and of similar dimensions in each. As far as the rest is concerned, the length of D G or H F, in fig. 209, must always be exactly equal to the length of F D or H G, in fig. 210. The elevation of the ends of the two boards to be joined are shown in figs. 211 and 212, fig. 211 representing the end of the front, and fig. 212 the end of the side. In figs. 213 and 214, the bevels or mitres at A, A, and the pins in one and the sockets in the other are drawn in

How to make the mitre dove-tail.

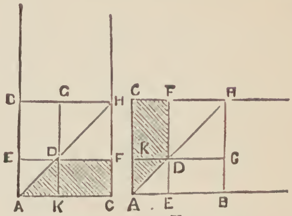


FIG. 209. SECTION OF FRONT. FIG. 210. SECTION OF SIDE.
MITRE DOVE-TAIL.

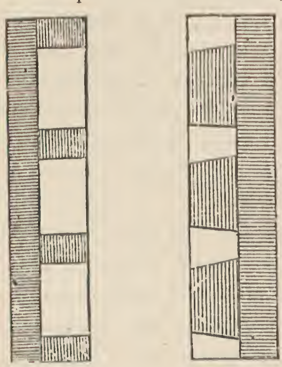


FIG. 211. END OF FRONT. FIG. 212. END OF SIDE.
ELEVATION OF MITRE DOVE-TAIL JOINT.

isometrical perspective. It is not possible, for obvious reasons, to give an illustration of this joint when fitted together and complete, nor indeed would it be needful even if it were possible.

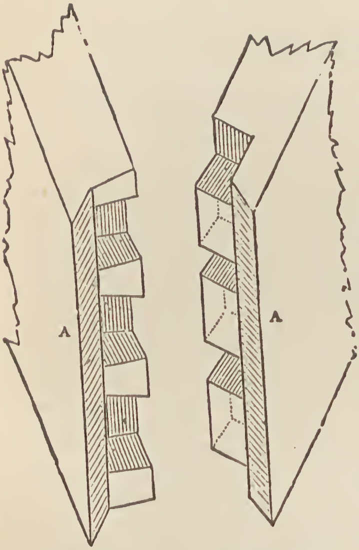
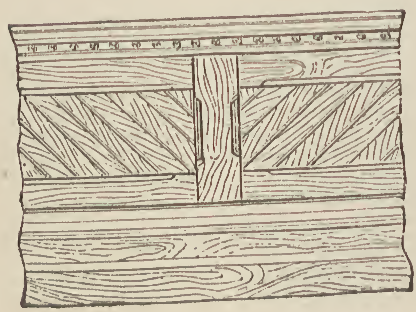


FIG. 213. FRONT. FIG. 214. SIDE.
MITRE DOVE-TAIL IN ISOMETRICAL PERSPECTIVE.

Illustrations helpful in making these joints.

462. By the aid of the illustrations no amateur can fail in making this joint, if he understand the mode of making the single dove-tail and of keying two pieces of wood together at an angle. He will find it a difficult piece of business no doubt, but patience and perseverance will enable him to overcome this and all other difficulties that may present themselves in the various operations that have to be performed in Carpentry and Joinery. Of course he will readily understand that it is in cabinet-making, rather than in carpentry and joinery proper, that such a joint as the mitre dove-tail joint is chiefly required. For all operations in which strength, rather than nicety, is requisite, the simpler kinds of joints, which are easily and more quickly made, will be found to be both suitable and sufficient in every respect.



CHAPTER VIII.

THE CARPENTER'S BENCH AND ITS VARIOUS FITTINGS. THE SAWING STOOL AND TRESTLES.

The Carpenter's Bench—Ordinary small-sized Bench—Utilisation of Space under Bench—Bench may be Fixed or Movable—Better Fixed for Amateur—How to Manage Fixing—Convenient Dimensions for Bench—Bench for Temporary Service—Preliminary Operations—Construction of End or Trestle—Front of Trestle—Connection of the Trestles—Diagonal Braces: their positions for back—To keep Trestles from Displacement—Construction of Front—Planing-board in front, etc.—Completion of Frame—Making and putting on top—Fittings for Bench—Substitutes for Bench-stop—Substitute for Bench-vice—Construction of contrivance—Another simple substitute—Merits of this kind of Bench—Amateur will make better Bench—Ordinary Carpenter's Bench—General principles of Construction—Convenient Dimensions—Preparation of different parts—Joining pieces together—Double Tenon desirable—Construction of Bench continued—Tenons of uppermost bars—Completion of Frame—Uprights for Bench—Centre rail in front of Bench—Provision in front for screw of Bench-vice—Well in Bench for Tools—Another mode of making Well—Front of Bench—Bench-vice: its construction—The Bench-screw—Cost of Bench-screws—Uses of the Bench-screw—Additional supports for Boards—Construction of top of Bench—Covering for Well—The Bench-stop: its construction—An additional hand—Iron hold-fast for Bench—Its construction and operation—Improved Hold-fast—Hold-fasts as substitute for Bench-screw—Hold-fast useful to amateur—Improved or Patent Bench-stop—The Shooting-board—Its construction and principle—Utility of Shooting-board limited—Universal Shooting-board—Its construction and principle—Evil of ordinary Bench-screw—Regulation of Parallelism between Bench and Bench-vice—Croix de St. Pierre—Its construction and action—Broad check: why preferred—Mode of preserving Parallelism—The Runner—Adaptation of Runner to Screw—Laws' Bench—Its dimensions and construction—The "Composite" Bench—Its dimensions and construction—Wheel and Treadle—Suitable for fixture against wall—Objections to ordinary Bench-vice—Standard Instantaneous Grip Vice—Its construction and action—Advantages of Grip-vice—Its adaptability to various requirements—Syer's Improved Portable Cabinet Bench—Its construction and advantages—Entwistle and Kenyon's Instantaneous Grip Parallel Vice—Principle of construction—Adjuncts to Carpenter's Bench—Trestle or Sawing-stool—Its dimensions and construction—Notch in end of Trestle—Clamps: their uses—Assistance rendered by machinery—Motive power for Amateurs—Mode of fitting and working a Circular Saw—Multiplication of velocity—Guide slip for regulating width to be cut.

463. ONE of the most indispensable essentials to the performance of operations in Carpentry and Joinery is the carpenter's bench. Nothing can be fairly done without it—except sawing, for which the stool is wanted; or mortising, which may also be done on a couple of stools or

trestles, although small mortises may be cut on the bench. Planing must be done entirely on the bench, for, as it has been said, in planing the surface of a board it must be laid flat on the top of the bench and butted against the bench-stop; while in planing the edges, the board must be laid along the side of the bench, being supported on pegs (for the reception of which holes are made along the side itself) in the middle, and at one end nearest the operator, while it is gripped and held tightly against the side by the bench-jaw or vice at the other end.

The carpenter's bench.

464. An ordinary carpenter's bench of small size, with a bench-vice and bench-stop, may be bought or made by a carpenter, ready for the amateur's use, at about 25s., but a tolerably good second-hand bench may often be picked up at the wood yard for 10s. or 15s. An excellent bench may be had for 50s., but when fitted with various appliances and turned out in the best manner, they will range upwards in price from this amount to £10.

Ordinary small-sized bench.

465. A bench of this description, however, is too often a bench and nothing more. Unlike a table, below the bed of which there must be nothing in order that the legs of the persons that are sitting round it may be thrust beneath it, the space under the carpenter's bench may be utilised, and almost every square inch of the space between the four legs turned to good account. So having knocked together a rough-and-ready article that may serve the purpose until the bench can be made, it will be good practice for the amateur to make one for himself, which he may contrive in such a manner as may best suit his own convenience.

Utilisation of space under bench.

466. A carpenter's bench may be either fixed or movable, and with regard to position it may be against a wall of the workshop or shed or it may stand in the middle of it, so that there may be free passage all round it. In nine cases out of ten the amateur will find it convenient to have it against the wall of his shed, and immediately under the window that lights it, if possible. A large bench need not be fixed, as its own weight will keep it in position; but a small one, such as an amateur artisan will generally have, will be all the better for being secured to the side of the shed or to the ground, if possible. For the amateur, then, there can be little doubt that the bench should be against a wall and fixed; but of course there are cases in which this would be impossible, and in determining position, etc., every one must be guided by the necessities of situation, light, etc., and settle these points as may best suit his own convenience.

Bench may be fixed or movable.

Better fixed for amateur.

How to manage fixing.

467. The fixing is easily managed. Four iron brackets, having two arms at right angles to each other, and pierced and countersunk for screws, will be all that is necessary. Suppose in fig. 215 that one leg of the end of a bench is represented, the bench being placed against a wall, perhaps of boards. If a bracket be screwed to the bench and the boards, as at A, at this end, and one at the other, the bench cannot be pulled away from the wall; and if others be placed against the *front legs*, in the manner shown at B, the bench cannot be raised from the ground. In the illustration, for convenience' sake, the bracket is shown fixed to the back leg; but this is of no importance, as it is only the manner of using these brackets that it is sought to explain. When the bench stands against a wall, a wooden rail must first be fixed to the wall in a horizontal position, to which the bracket may be screwed. As for the floor, if this be of stone, concrete, or even earth, it is always desirable that the bench should stand on a very low platform, and it will be better for the wall behind the bench, if it be of brick or stone, to be match-boarded. The utility of this will appear presently.

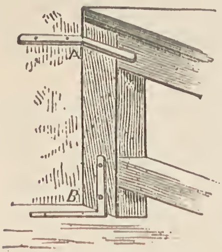


FIG. 215. FIXING BENCH WITH BRACKETS.

Convenient dimensions for bench.

468. First, as to the dimensions of a bench; these must depend very much upon space, for the bench must be made according to the room at command, very much in the same way that a coat must be cut according to one's cloth. The following will be found convenient dimensions: *length*, from 5ft. to 7ft.; *breadth*, from 1ft. 6in. to 2ft. 6in.; *height*, from 2ft. 6in. to 3ft. The height must be regulated by the height of him who has to use it. A tall man will require a higher bench than a short man, for it is desirable not to stoop over the bench more than is absolutely necessary in planing, etc. A nice size for ordinary work done by the amateur is, *length*, 6ft.; *breadth*, 2ft.; *height*, 3ft.

Bench for temporary service.

469. Next let us glance at the way in which a bench for temporary service may be put together, as it is often convenient to knock up a rough bench of this kind for use when making any structure out of doors at too great a distance from the workshop to allow of constant walking backwards and forwards for planing and other operations that must be done at the bench.

470. First get out four pieces of quartering, about 3in. × 2½in., and some strips of board, about 3in. wide, or a little more, and 1in. thick; a board of white deal, 11in. wide, may be ripped down in three lengths

for this purpose. Three pieces of the same kind of board 6ft. long must also be provided, and some 2in. and 2½in. screws ; about three dozen of each will suffice. In putting together a temporary bench of this description, or any kind of work that is to be taken to pieces again, use screws instead of nails, as by screws less injury is done to the wood, and it may be utilised when it has served its first purpose for something else. And more than this, no nails or fragments of nails will be left in the wood to hurt teeth of saw or edge of plane-iron.

Preliminary operations.

Construction of end or trestle.

471. Having got the wood all ready, take two pieces of quartering, and lay them down on a flat surface parallel to each other, and two feet apart, from outside edge to outside edge, that is to say, from A to B, in fig. 216, and from C to D ; cut a piece of wood E from the wood that you have ripped down, taking care that the ends are square with the top and bottom, and screw it to the quartering with some of the larger screws — not less than four being used. Then screw on another piece, F, diagonally from A to D, taking care that the pieces of quartering are still exactly two feet apart along the line included between C and D. Turn over the pieces of wood thus screwed together, and screw on the pieces G, H, in a precisely similar way on the other side. When raised from the ground the trestle that has thus been made will be found to be as strong as a castle. Complete the work by screwing on a piece of wood, K, on the outside face of one of the legs, reaching from the ground to a line just *ten inches* from the top of the leg. This, it must be borne in mind, will be the *front* of the trestle. The reason why this piece is to be screwed on will be apparent presently. As soon as this is done make another trestle similar to this with the remaining two pieces of quartering, and some more of the wood that was ripped down at the commencement of the work, when getting out the wood all ready for it.

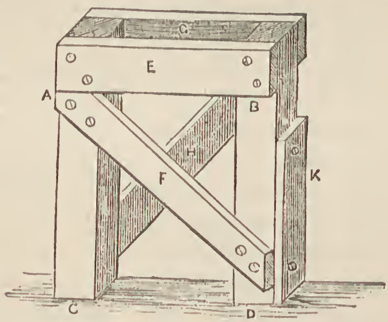


Fig. 216. TRESTLE OR END OF BENCH.

Front of trestle.

472. It is now necessary to connect the trestles in such a way as to offer a solid framing for the reception of the boards that are to form the top of the bench. The back and front will be connected in a

totally different manner, and to make this perfectly clear, the elevation of the back is given in fig. 217, the elevation of the front in fig. 218, and the plan of the top in fig. 219. The trestles have been made precisely alike, so that when they are placed upright the diagonal brace F, in the illustration of the trestle, will be *outside* in that which stands to the left hand, and *inside* in that which stands to the right; and conversely the brace H will be *inside* in that which stands to the left hand, and *outside* in that which stands to the right. Care must be taken to preserve this arrangement with the braces of the trestles, or otherwise some difficulty will be occasioned in fixing the diagonal braces at the back. Having cut two slips of wood, one 5ft. 6in. long and the other 5ft. 8in. long, place the trestles so that the front of each rests on the ground, and the back is uppermost. Screw the shorter piece to the trestles, as shown in A in fig. 217, and the longer piece as shown in B. The object in having the upper piece 1in. longer on either side than the lower piece is, that its ends may abut against and cover the slip marked E in diagram of trestle, on one side, and the slip marked G on the other. Then screw on the diagonal brace C on the outside, and the brace D, also placed diagonally, on the inside. In fig. 217, E shows the end of diagonal brace A on one side, and F, end of diagonal brace H on the other side, in the diagram of the trestle. Of course these ends are not in the same but in different trestles respectively.

Connection of the trestles.

Diagonal braces: their positions for back.

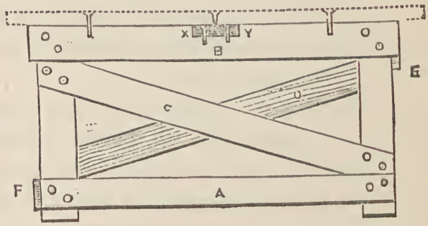


FIG. 217. ELEVATION OF BACK OF BENCH.

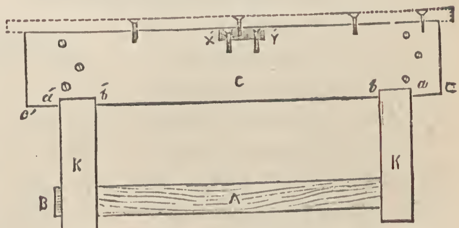


FIG. 218. ELEVATION OF FRONT OF BENCH.

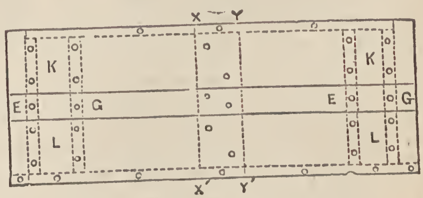


FIG. 219. PLAN OF TOP OF BENCH.

473. To keep the trestles from displacement during this operation, it will be found useful to nail two slips of wood across to the face or front of the trestles before placing the front on the ground, taking care that the trestles are kept the correct distances apart, which is 5ft. 6in., the length assumed as convenient for the length of the slip A in fig. 217. Before turning the frame over to put on the front, screw to the inside of the front legs the slip shown at A in fig. 218. In this figure, B shows the grain end of the diagonal brace F, in the diagram of the trestle. As soon as the slip A in fig. 218 has been screwed on, the frame must be turned over so that the front is uppermost and the back on the ground. It may be asked why the slip A (fig. 218) is not screwed on to the *outside* of the front instead of the inside. The amateur who is making the bench may screw it to the outside if he likes; but by reason of the slips that were screwed to the face of the front leg of each trestle (see K in diagram of trestle), it would project beyond the face of the board in front of the bench, and be in the way. If he must put it on the outside it should be done as in fig. 220, and in the following manner: the board C and the slip A must first be firmly fixed in their places, and then a piece D screwed on below A, and another piece B between A and C, so that all the pieces which thus combine to form the front of the bench are flush with one another wherever they meet and join. It is preferable, however, to keep the slip A, as in fig. 218, behind, and to have the slips K, K, in one single piece.

To keep trestles from displacement.

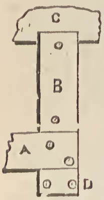


FIG. 220. SLIP IN FRONT OF TRESTLE.

Construction of front.

474. The board C, as well as the pieces intended to form the top of the bench, was cut exactly 6ft. in length. Before putting these in their places it may be as well to *rub them over* with a plane, as the carpenter says; but this need not be done especially, as the bench is merely intended to serve a temporary purpose. The board C is 11in. wide, and the top of each slip marked K is just 10in. from the top of the trestle, so two notches an inch deep must be cut in the lower edge of the board, so that it may fit over the top of each slip, the upper edge being on a level with the upper edge of the trestles on either side. As the length, from outside edge to outside edge of the legs of the trestles front and back, is 5ft. 6in., and the board C is 6ft. long, *a c* and *a′ c′* will be just 3in., and the length of the notches *a b* and *a′ b′* will be exactly the width of K, which is the width of the narrowest part of the quartering, namely, 2½in. Cut the notches so that they may fit tightly over the tops of the slips K, K; and when the board

Planing board in front, etc.

is fairly placed in position, as shown in fig. 218, screw it firmly to the trestles, taking care to bury the head of every screw well in the wood, to do which with ease a depression for its reception may be made with a bit for countersinking. Every screw must be greased before being driven into its place, as then it can be withdrawn easily whenever the bench is taken to pieces.

475. The frame is now nearly complete, but something more yet remains to be done before putting on the top, and that is to cut two notches—one at X Y in B in fig. 217, and the other at X′ Y′ in C in fig. 218—about 4in. long and 1in. deep, in order to receive a bearer, crossing the frame from the slip B to the board C, which will help to support the boards that form the top. This bearer is shown in the plan of the top in fig. 219 by the dotted lines X X′ Y Y′. When this has been secured with screws the frame is ready to receive the top, which will be 2ft. 2in. from outside to outside. The board K K must therefore be placed on the top, so that its outer edge is flush with the slip B, in fig. 217; and the board L L, so that its outer edge is flush with the surface of the board C, in fig. 218. They must then be screwed down, as indicated in the figures, to the slip B, the board C, the cross-pieces E, G, of each trestle, and the bearer X X′ Y Y′, whose positions are shown by the transverse dotted lines in fig. 219, the horizontal dotted lines showing the edges of the slip B and the board C. The dotted lines in figs. 217 and 218 show the position of the boards K K, L L, when placed on the top of the frame. A space of 4in. now remains between these boards; this may be left as it is, but to save the annoyance of small tools, etc., tumbling through when thrown on the bench, it is better to cut a slip to fit tightly into the opening, and close it up altogether.

Completion of frame.

Making and putting on top.

476. The bench is now complete as far as it goes, and is strong enough for any practical purpose, though not very good-looking. There are, however, certain adjuncts required, which must now be described, and these are fittings which will serve as substitutes for the bench-vice and the bench-stop. If the amateur is content with a bench of this sort until he can find time to make a better one, he may as well put in a bench-stop at once, as described further on; but in the bench under consideration it is sought to injure the wood as little as possible, and a substitute for a bench-stop may be found in the insertion of two thick, stiff screws close together, for planing the surfaces of pieces of quartering, etc., and further apart for planing the surface of a board. Indeed, supposing the end of a rough bench

Fittings for bench.

Substitutes for bench-stop.

to be represented in fig. 221, A being the board nearest the operator, a line B C, at right angles to the edge D E, may be drawn with the square, and two screws inserted about 1in. or 1½in. apart, as at F G, and a third about 3in. or 4in. from G, as at H. These screws can be raised or lowered at pleasure to suit the thickness of the wood that is being planed. The screws should be thick, as it has been said, and have a large deeply-cut thread. The same object may be attained in another manner, namely, by nailing or screwing down a slip of wood to the top of the bench, as at K; but as no piece of wood that is less than, or equal to, the slip in thickness can be planed with such a contrivance as this, as the plane would not pass over it, it seems that the screws afford a more serviceable arrangement.

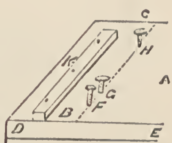


FIG. 221. SUBSTITUTE FOR BENCH-STOP.

477. A contrivance for holding a board against the front of the bench while its edges are being planed must now be sought out, and this may be effected in the manner shown in fig. 222. At the distance of from 9in. to 12in. from the end of the board which forms the front of the bench and along its entire length, with this exception, a slip of wood, A, is screwed, about 1¼in. thick and 1½in. deep. This slip may be fixed in this position, and remain so until the bench is taken to pieces; its upper edge should be about 4in. from the lower edge of the front B of the bench. As there is now a space of 8in. between the upper edge of this slip and the surface of the board C, which forms the top of the bench in front, it is manifest that any board whether 9in. or 11in. wide may be planed along its uppermost edge, while the lower edge rests on the slip, as shown in the diagram by D. If the wood whose edges are to be planed be very narrow, another temporary slip must be screwed on to the bench front higher up, as a rest to receive the lower edge of the board, so that the upper edge may be raised above the top of the bench. A stout piece of wood, say 2½in. thick, 6in. wide, and 8in. long, that will not readily split, should then be cut in the shape shown at E, in fig. 222, above, and in longitudinal section in fig. 223. Let *de* in fig. 223 be 3½in., then, through *c* make a vertical saw-cut to *a*, just half the depth of *de*. Set off *bf*, equal to

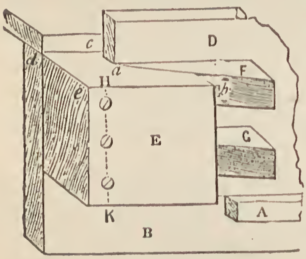


FIG. 222. SUBSTITUTE FOR BENCH-VICE.

Substitute for bench-vice.

Construction of contrivance.

a quarter the depth of *d e*, and then join *a b*, and cut through the wood from *b* to *a*; the part that is severed from the block by the saw-cut, *c a* and *b a* will come away, leaving a slanting face *a b* about 5in. long or very nearly so. The block is then screwed to the front of the bench, as shown at E in fig. 223; but care should be taken to bring the line H K, (fig. 222) through which the screws pass, exactly opposite the central line down the front of the front-leg of the trestle that stands to the left, so that additional strength may be obtained by the entry of the screws into the leg of the bench. Substantial screws, at least 5in. in length, should be employed for this purpose, and the heads should be deeply buried in the block, provision being made for this with a countersinker. When the board has been placed in position, abutting against the surface *a c* of the block, two wedges, F and G, flat on the side next the board and bevelled on the other side to correspond with the slanting surface of the block *a b*, must be driven in with two or three sharp blows. These wedges will hold the board as firmly as the ordinary bench-vice. There are other means of making a stop, or *quasi*-vice, to hold the end of the board, but they need not be described. One or two methods will doubtless suggest themselves to every intelligent amateur mechanic.

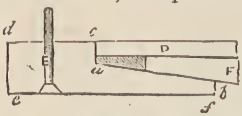


FIG. 223. SECTION OF SUBSTITUTE FOR BENCH-VICE.

Another simple substitute.

478. Another plan for securing the board, whose edges are to be planed, to the front board of the bench, is to make some buttons of the shape shown in the annexed figure in section, and screw them to the front board, so as to hold down the lower edge of the board, and the end furthest from the operator. The space, or rebate, in the button at A may be made 1in. in depth, so as to button tightly over an inch board. If the board be less in thickness, a slip of wood equal to the difference between the space at A and the thickness of the board must be inserted, so as to keep the board whose edges are to be planed from moving.

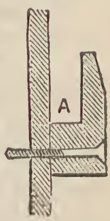


FIG. 224. BUTTON FOR HOLDING BOARD.

Merits of this kind of bench.

479. The merits of the bench that has just been described are, that it is easily made, even by an amateur who can do little more than make a straight saw-cut, and that there is nothing that presents any difficulty that cannot be overcome in the way of providing substitutes for the bench-stop and bench-vice. The amateur, however, will never rest content with such a bench as this, however well it may serve his purpose for temporary work out of

doors, or as a makeshift even in the workshop itself; and one of his first serious undertakings in carpentry, when he is able to manage his tools tolerably well—provided always that he has not purchased a bench, either new or secondhand, or had one made by a carpenter—will be to make a bench for himself.

Amateur will make better bench.

480. This bench will either be an ordinary carpenter's bench, made very much on the lines that we have already laid down for the temporary bench, or one replete with shelves, drawers, recesses, and various fittings of one kind or another suited for his peculiar requirements. Let us first consider the chief points in a plain bench, made in the usual manner, and then see what mode of construction may be adopted for utilising the open space that there is between the four legs of the frame and the top of the bench and the ground on which the bench stands. Supposing the bench were 3ft. high, 2ft. wide, and 6ft. long, outside measurement every way, roughly speaking there would be about 36 cubic feet of empty space below the table, which is too much to be wasted in a small workshop, especially when it may be turned to account with but little trouble, as we shall see presently.

Ordinary carpenter's bench.

General principles of construction.

481. For the ordinary carpenter's bench that we are about to describe, let us take the above dimensions, namely, height 3ft., width 2ft., and length 6ft., as these will be found convenient for the majority of amateurs, and let us see how it may be provided with bench-stop, bench-holdfast, and ordinary bench-vice with wooden screw. We will next consider varieties in the form of bench-vices and bench-stops, and after describing the shooting-board, a useful adjunct or accompaniment to the bench, used for squaring-up the edges of pieces, proceed to what we may term, for want of a better name, the "composite" bench.

Convenient dimensions.

482. The first step to be taken is to provide some quartering of different dimensions, that is to say, about 12ft. of 3in. × 2½in. for the uprights or legs, about 36ft. of 2½in. × 2¼in. for the horizontal pieces of the frame, 4ft. of board 9in. wide and 1½in. thick, and 24ft. of board 9in. wide and 1¼in. thick. If the bench is to be 3ft. in height from the ground to the top of it, cut off 4 lengths of 2ft. 11in. from the wood provided for the uprights, and plane them up. Next cut 5 lengths of the smaller quartering 6ft. long, and 2 lengths 2ft. long, and plane these up also; lastly, cut 2 pieces of the 1½in. board 20in. in length, and plane up these as well, bringing the sides to a smooth surface, and making the edges true and square.

Preparation of different parts.

Jointing pieces together.

483. When this has been done, the necessary steps may be taken for putting all these pieces together, which will be done with mortise and tenon joints. Let us frame together the ends first of all, and let fig. 225 serve as an illustration of the method to be adopted in doing this. In this representation of either end of the bench, let the broad side or width of the uprights be supposed to face the reader, as shown in A and B. The piece C has already been cut 20in. long; cut D to the same length, and then proceed to cut the ends of each into tenons 1in. in length. Cut the tenons at either end of D to one-third the thickness of the wood; but let the ends of C be cut in the

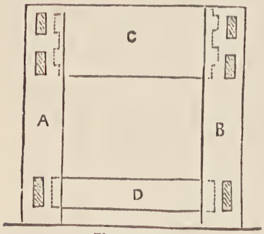


FIG. 225.
END OF CARPENTER'S BENCH.

manner indicated by the dotted lines in fig. 225, and on a larger scale in fig. 226. The wood is 1½in. thick, therefore a rebate must be cut in it 1in. wide and ¾in. deep, and the rebate thus made, as shown in transverse section at A, must be cut as shown in B, in which there is a tenon all the way down, for the width of ½in., the remainder being cut away so as to leave two projecting pieces of about 2¼in. long, the remaining 4½in. being equally distributed in lengths of 1½in. over the three notches at *a*, *b*, and *c*. This is an adaptation of the form of tenon shown in page 188, at fig. 175. Cut mortises in A and B to receive the tenons that have been cut at the ends of C and D, and fit the pieces together. The tenons should fit tightly into the mortises, but not so tightly that they cannot be withdrawn without great force. The opposite end must be made in precisely the same way.

Double tenon desirable.

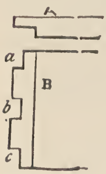


FIG. 226.
FORM OF TENONS.

Construction of bench continued.

484. The narrow faces of the uprights were to be 2½in. wide, and it will be useful to suppose that these are the actual dimensions after the wood has been planed up. The bench is to be 6ft. long, from end to end, and the length of the horizontal pieces of the framing, from shoulder to shoulder of the tenons at the ends, must be exactly 5ft. 7in. We are supposing that the boards composing the top and front are to be 6ft. long, and that their ends are to be flush with the ends of the bench; but such a frame as is now being described will allow of the use of boards 6ft. 6in. long, so that they will overlap 3in. at the ends on either side. To return to the horizontal pieces of the framing, the tenons at the ends of these must be 2½in. long and one-third of the width of the stuff. The tenons at the

ends of the uppermost horizontal bars should be cut as in fig. 227, and the mortises as shown by the shaded parts in fig. 225; three in the front legs, and two—one at top and one at bottom—in the uprights behind. A third bar may be added in the back part as well as in the front, and it will be as well to do this, for it will give additional strength and firmness to the bench.

FIG. 227. TENON OF UPPER BAR.

Tenons of uppermost bars.

The reason is now clear why the tenons of the pieces C and D, in fig. 225, are not made longer than they are, for being no more than 1in. in length they do not interfere with the tenons of the horizontal pieces being carried right through the uprights, so as to show the end grain of the former. When the whole of the framing has been put together, the front will present the appearance represented in fig. 228, and the back will look like this too, if a third rail has been put in between the two others at top and bottom; and, if not it will look like fig. 228, with the middle rail A removed. When it has been ascertained that all the tenons fit fairly tight into the mortises, and the shoulders of the tenons fit closely to and squarely against the parts on which they butt, they must be glued and put into place for the last time, and the whole frame pinned together with wooden pegs, driven through each mortise and the tenon that is thrust into it. The frame is now complete, and ready for the top and front.

Completion of frame.

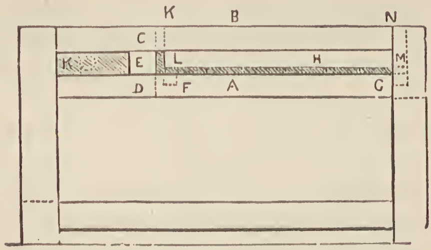


FIG. 228. FRONT OF CARPENTER'S BENCH.

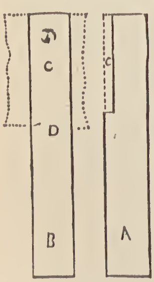


FIG. 229. UPRIGHTS IN FRONT OF BENCH.

485. In making a bench it is usual to have the uprights intended for the front legs or uprights 1¼in. wider than the back uprights, so that the face may be cut as shown in fig. 229 for the reception of the fronts. In this figure, A shows the side, and B the front of a piece thus cut. The piece C is taken right away, so that the board that forms the front of the bench may be dropped into the recess thus made. The top of the projection is cut in a slanting direction from the *inside* to the *outside* of the upright, and the board notched accordingly, to fit over the angle. The simple notch shown in the trestle of the temporary bench does equally as well, although it

Uprights for bench.

weakens the board more and there is more chance of the end or corner beyond the leg splitting off or being knocked off. As no provision of this kind has been made for letting the front board into the upright, all that is required to be done is to screw a piece of wood on to the face of the upright of the same thickness as the board, in order that the latter may appear flush with the face of the projecting part thus added to the upright. The top should be cut of the shape shown in fig. 229, and the board notched accordingly.

486. With regard to the centre rail A in fig. 228, it may be added to the framing or dispensed with altogether, at the pleasure of the maker of the bench. When introduced it gives additional stability to the structure, if we may apply such a word to a simple framing of uprights and rails; and although its presence is more important in the front than in the back of the bench, it is, we are inclined to think, better to have it in the back also, for reasons which will appear presently. It is also desirable to put a board at the back of the bench similar to that which is fixed in front, faces being screwed on to the legs below to bring them flush with its surface, or a rebate being made for its reception as already described. The boards at front and back are not to be screwed on until the interior of the bench is completed, which we will now proceed to describe.

Centre rail in front of bench.

487. At the end of the bench to the left hand the wooden screw of the bench-vice will enter, and work backwards and forwards, and provision must be made for its reception. The space between the boards in front and behind must be left open so that nothing may hinder the progress of the screw, and no attempt must be made to enclose the bench by boarding up the space within which the screw works, as this would prevent us from making proper use of the old-fashioned bench-stop and bench-holdfast, if these be used in putting the bench together and fitting it up. The end to the right hand, however, may be boarded at the bottom so as to form a well for the reception of saws and large tools, which it may be convenient to stow away in such a depository. Returning, then, to fig. 228, and taking this to be a fair example of the framing requisite in front and rear of the bench, the central rail A being introduced in both parts of the frame, insert a cross-piece of wood from front to back as shown at C D, cutting grooves for its reception to the depth of ½in. in the rails A and B, and letting the end showing the grain project between the rails on either side and come flush with the outer surface of the rails, as at E. Screw a slip of wood, or *cleat*, as it is

Provision in front for screw of bench-vice.

Well in bench for tools.

Another mode of making well.

technically termed, to this cross-piece at F, and another to the end rail at G, and then lay pieces of board as shown at H from rail to rail, the ends being flush with the outer surface of the rails on either side. A shallow well about 6 inches deep will thus be formed for the purpose indicated to the right of the bench. If the central rails have been dispensed with and it is still desired to make a well, a convenient method of doing this is shown in fig. 230. In this let A represent the inner

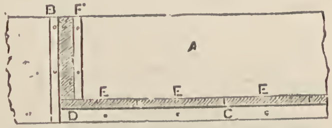


FIG. 230. METHOD OF MAKING WELL IN BENCH.

surface of the board at the back of the bench. To this, at a distance of two-thirds the length of the bench from the right-hand end, screw the perpendicular slip B, and the horizontal slip C, the latter being fixed flush with the edge of the board if it be wished to make the well as deep as possible, or higher up if a shallow one be desired. Let the end D abut against the slip B. Screw slips similar to these to the inside surface of the front board, and when the framing has been completed by fixing these boards in the proper position, lay boards as at E, E, E, along the horizontal slips on either side, the slips forming supports for the ends of the boards. Let the side of the first board touch the slip B. Then, at the distance of ¾ in. or 1 in. from B, screw on another slip F, which forms with B a groove on either side, into which a board ¾ in. or 1 in. thick, according to width of groove, may be dropped, forming one end of the well, the end rail of the framing, as before, constituting the other end. Provision for the well must in all cases be made before the frame is put together, especially when a centre rail is used in the framing at front and back, as shown in fig. 228 at A.

488. When the front board is screwed on to the framing, if it be allowed to project a little beyond the uprights, say to the extent of two or three inches, the appearance or elevation of the front of the bench will be like that shown in fig. 231; but

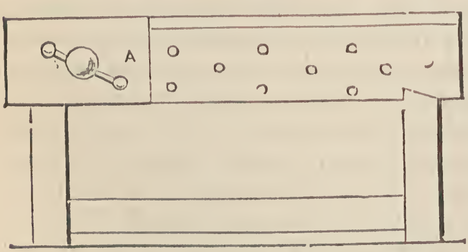


FIG. 231. FRONT OF BENCH WHEN COMPLETE.

Front of bench.

the bench is yet incomplete, for the bench-stop and bench-vice have to be added, and the top has to be put on. Of the bench-vice we can speak

at once, but as the old-fashioned bench-stop has to pass through the top, mention of this had better be left until the top comes under consideration.

Bench-vice: its construction.

489. The bench-vice—it must be remembered that we are now speaking of the wooden adjunct to the bench, and not the iron holding-tool also called a "bench-vice," because it is often attached to one end of the bench to hold a piece of metal for filing—consists of a broad, solid cheek, a wooden screw, and a nut or female screw attached to the framing or front board in which the screw works. In fig. 232 the construction of the bench-screw is shown in section, with the exception of the screw, the thread of which is drawn entire, to show its purpose the better. The screw A B has a solid head A, perforated, as at C, for the reception of a wooden peg or bar D, which works easily in the hole C,

The bench-screw.

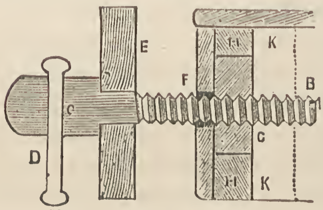


FIG. 232. BENCH-SCREW.

and is furnished with a knob at each end to prevent it from slipping out while the screw is being turned, or when it is at rest, if this bar happen to be vertical. The neck of the screw passes through a solid piece of wood E, about 18in. long, 9in. wide, and 2in. thick, and the shoulder of the screw-head A abuts against this board and forces it against the front of the bench when the screw is turned in, or against anything that may be placed between this solid cheek and the face of the bench holding it firmly. The thread of the screw is deeply cut, and the screw itself, after passing through a hole F cut for it in the front board of the bench, works in a large nut or block of wood in which a female screw is cut, and which may be fixed between the rails of the bench H H, as at G, or bedded against and screwed to these rails, as shown by the space K K. If there be no rails—for sometimes even the top rail is dispensed with, much to the detriment of the bench—the block in which the screw works must be attached to the front board. The position of the bench-vice is shown in fig. 231 at A, and that of the block in which the screw works at K in fig. 228. This, it must be said, is the most ordinary form of bench-vice or bench-screw that is used.

Cost of bench-screws.

The screws may be purchased at from 1s. 6d. to 2s. 6d. each, according to size, at any shop where carpenters' tools are sold. The cheek is not included in the screw. Bench-screws of iron are more expensive, costing from 3s. 6d. each to 9s. or 10s. Excellent iron and wood bench-screws are supplied by Messrs.

Churchill and Co. The prices of the wooden bench-screws are :—2in. in diameter, 1s. 6d. ; 2¼in., 1s. 7d. ; 2½in., 1s. 8d. The wrought iron bench-screws, cut with double thread and fitted with wood handles and movable collars are :—1in. in diameter, 1s. 6d. ; 1⅛in., 1s. 10d. ; 1¼in., 2s. 3d. ; 1½in., 3s. These bench-screws are remarkably cheap, and are strong, well made, and serviceable.

490. For cutting a tenon at the end of a rail or upright, the wood may be placed in the bench-screw and screwed tightly against the bench ; but when it is necessary to plane the edges of a board, it is requisite to provide some support for it along the front of the bench. In the temporary bench this was managed by screwing slips horizontally to the piece of wood that formed the front ; but in the permanent bench the same end is secured by making two or three rows of holes in the front board, as shown in fig. 231, into which pegs are inserted, on which the lower edge of the board rests, the end furthest from the operator being held tightly in the bench-screw.

Uses of the bench-screw.

Additional supports for boards.

491. Let us now proceed to the construction of the top of the bench, which is shown in plan in fig. 233. Of this it may be first said that if there be no well in the bench, all that is to be done is to screw the two 9in. boards, that were originally provided to form part of the top, on to the rails and boards at the front and back of the bench, and then to fill up the space of 6 inches that remains between these boards with another board cut to fit ; but if there is to be a well, cut a strip 1½in. wide off each board, reducing them to a width of 7½in., leaving a space of 9in. between them when put in the position they are to occupy. The solid lines in the figure represent the edges of the boards as they appear to view when the top is complete. The dotted lines from A to B and from C to D represent the edges of the boards forming the front and back of the bench ; and the dotted lines from A to C and from B to D the edges of the end rails of the bench. Those from E to F represent the upper edge of the board let into grooves formed by slips, as shown in fig. 230, to form one end of the well, the end rail of the bench to the right being the other. Two bearers are notched into the boards at front

Construction of top of bench.

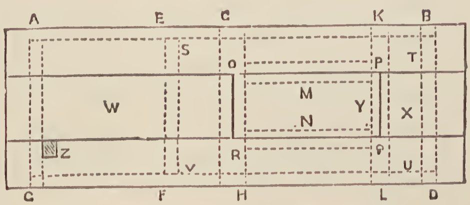


FIG. 233. PLAN OF TOP OF BENCH.

and back, and fixed in position as shown by the dotted lines from G to H and from K to L. Before the boards forming the top are put on, the rectangular space S T U V is entirely open, forming the well. The boards on either side may now be laid on the top of the bench and marked, so that two slips, M and N, may be screwed to their under surface, forming, with the bearers G H and K L (or such of these as may project beyond the boards W, X, whose edges rest on them), a resting place for the board Y, which forms the cover for the well. A rebate might have been cut in the board on each side of the well at M and N to receive the cover, which must also be rebated, to fit into the rebates of the others, and the slips dispensed with; but the amateur will often find it useful to form a rebate in this manner instead of cutting one, and this mode of doing so may as well be adopted here. Moreover, it suits the width of the boards employed, which are 9in. wide; and if a rebate of ½in. had been cut on either side it would have been necessary, in order to save waste, to form the rebate in the well cover by bradding on slips ½in. square, so that it is as broad as it is long any way, to use an old saying. Next, a board 9in. wide and 6ft. 6in. long must be taken, and cut into three parts, corresponding to the parts marked W, Y, and X in the figure. The pieces W and X may be joined to the boards on either side by a groove and slip-feather, or by a dove-tail groove (see p. 195); the whole being glued up, but the amateur will find it easier to dowel them together with pegs. When dry the top may be screwed on to the bench, or nailed on—it does not matter which; but in either case the heads of the screws or nails, as the case may be, should be deeply buried in the wood. When the top has been screwed on, the opening O P Q R is left for the admission of tools into the well, and into this opening the piece of board Y will drop nicely. It will perhaps occur to the reader that the opening to the well has been made as large as possible first to facilitate the putting in and taking out of such a tool as the hand-saw, and to leave as little space as possible covered between the ends and sides of the well, so that the hand may be passed with ease to any corner of it in search of any small tool that may have been put in or dropped in. The amateur, however, is cautioned against keeping any small tools in such a depository as the bench well, which is best calculated for saws, planes, squares, hammers, and any large and heavy tools of this kind.

Covering for well.

492. The next thing to be considered is the bench-stop, against which a board may be fixed during the process of planing its sides. In its simplest form it is a rectangular block of wood, about 2 inches square

and 8 inches or 9 inches long. The shaded square marked Z in fig. 233 is a good place for it, because, as shown in fig. 234, in which A is the bench-stop in section, one side lies closely against the end rail B on the left of the bench, while against the other side a stop can be abutted as at C; and, indeed, additional stops may be placed on the other sides, so that the depth of the socket in which the bench-stop works may be increased as much as possible. A hole is cut in the top of the bench for the bench-stop to pass through, and the top of the stop is furnished with a piece of iron, D, cut so that its edge presents four or five points which enter the edge of any piece of wood pressed against it as at E, and prevents it from moving sideways. The stop is moved up and down by knocking it at the bottom or at the top as may be requisite, and when it is down its top should be flush with, or slightly below, the surface of the top of the bench, a groove being cut for the reception of the projecting teeth. With this addition the carpenter's bench, in its most simple and ordinary form, may be considered complete.

The bench-stop: its construction.

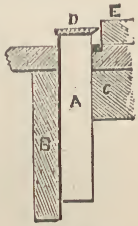


FIG. 234. BENCH-STOP.

493. There was an old Indian officer of artillery, long since gone to his rest, who was an adept in sketching and drawing in pen and ink and painting in oil colours. He was also very fond of smoking, and finding some little difficulty in managing his pipe or hookah, when he had his palette in one hand and his brush in the other, was prone at times to wish for a third hand as supplementary to the other two, which he could put on pipe duty when the other two were otherwise engaged. Possibly many a carpenter in olden times has wished for a third hand to hold down a piece of wood tight to the bench while he was cutting a mortise in it, holding his mallet in his right hand and a chisel in his left hand; and the wish, in process of time, was the parent of the bench-holdfast, in a certain sense.

An additional hand.

494. Anything more unpromising, at first sight, for the purpose for which it is used than the bench-holdfast can scarcely be found. Its shape, and the mode of using it, is shown in fig. 235. The holdfast is a simple hook of iron, one side of which is short and terminates in a broad flat plate, while the other side is much longer. When it is desired to make use of it in order to hold a piece of wood A, shown in section, tightly to the top of the bench B, the shank C is passed through a hole D, cut in the top of the bench, and larger than the diameter of the shank, and the wood is placed

Iron holdfast for bench.

under the flat disc E, and a blow or two given to the holdfast on the top of the bend F to fix it tightly. To prevent any injury to the surface of the piece of wood A from the disc of the bench hook, a piece of wood may be slipped in between A and the iron, which will prevent it from sustaining any damage. To make the hole at D a little deeper a collar, G G, may be attached to the under part of the bench in continuation of the hole. When it is desired to release the wood the hook must be hit lightly with the hammer at H, which will produce the desired effect. From the shape of the holdfast, whose arms diverge and become wider apart the farther they are from the bend F, it is manifest that a blow at F will cause the sides of the long shank or arm C to press tightly against the hole through which it passes at the points K and L, and it remains in this position because there is but little, if any, force in an upward direction to lift it out of its place. For this reason a blow at the back of the hook is necessary to loosen it and bring it up.

Its construction and operation.

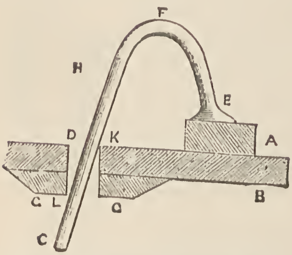


FIG. 235. BENCH-HOLDFAST.

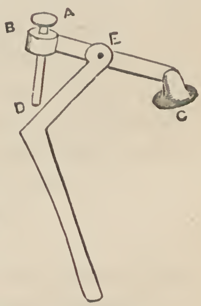


FIG. 236.
IMPROVED HOLDFAST.

495. In the improved holdfast shown in fig. 236, the principle of construction is the same, but the tightening of the hook and its loosening are effected by the action of a screw A, which passes through the end of the short arm B, opposite the disc C, and acts on the long shank at D, just above the part where it is bent to form an arm into which the short limb is fastened, as at E.

Improved holdfast.

496. A pair of holdfasts afford a useful substitute for a bench-screw in holding a piece of wood to the front of the bench so that its edges may be planed. The method adopted for using it for such a purpose as this is shown in fig. 237, in which A is the top of the bench, B the front, and C the wood whose edges are to be planed, all shown in section. A row of holes is made a little above the lower edge of the bench front, as at D, through two of which the long shanks of a pair of holdfasts are passed, as shown in the illustration. The ordinary holdfast costs but little, being merely a bent iron bar, and such as may be quickly made by any smith should

Holdfasts as substitute for bench-screw.

difficulty be experienced in procuring one. The improved holdfasts with screw are more expensive, ranging in price from 6s. to 9s. 6d., according to size and quality.

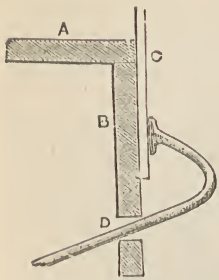


Fig. 237. Holdfast as bench-screw.

497. The amateur artisan will find it useful to add a simple holdfast to his tools, and to cut a hole in his bench through which to put the long shank; but he should trust to it merely for holding down work on the bench, and not as a substitute for the bench-screw. And when making a bench permanently for his own use, it will be better for him to provide himself with the improved bench-stop instead of fitting his bench with an old-fashioned one.

Holdfast useful to amateur.

498. The improved or patent bench-stop is shown in fig. 238. At A it is closed, at B it is raised ready for use. In appearance it looks something like a hinge, and indeed is made on that principle. A hole is sunk in the top of the bench for the reception of the stop, which is let into the wood until its top is level with the surface of the bench. On raising the screw E, the part D, which is attached to the lower part or bed C by a hinge joint, rises, and presents above the surface of the bench, as shown at B, a row of teeth, F, against which the edge of the board to be planed is pressed. Thus, with this patent bench-stop, the inconvenience of knocking the old-fashioned stop up and down to the desired height is obviated, the same effect being gained by a few turns of the screw. The price of this kind of stop ranges from 1s. 2d. to 2s. 3d., according to size.

Improved or patent bench-stop.

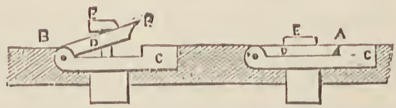


Fig. 238. Improved bench-stop.

499. The shooting-board has been mentioned in a previous page, and a description has been promised of it which it may be as well to give here. It is very simple, being merely two boards of different widths screwed together, so as to form a rebate in which any piece of wood whose edges are to be planed and squared up may be rested. It is used on the bench. It will be of great assistance to the amateur to possess one of these boards, which he may get made for him by any carpenter if he is not skilful enough to do the work for himself.

The shooting-board.

500. The construction and principle of the shooting-board may be

best explained by the aid of a diagram in section, as in fig. 239. In this A represents the top of the bench, and B the front, C being the shooting-board. This is composed of two pieces of wood, one a wide piece and the other a narrow piece, the narrow piece being laid on the wide piece as E lies on F. The boards are screwed together, and it is necessary that the edges G and H of both boards should be perfectly straight and even, and that the edge H should be parallel to the edge G. The boards thus constructed and put together form a broad rebate, in which any board K whose edge is to be squared up is laid. To do this, the shooting-board is laid on the bench as shown in the diagram, and abutted against the bench-stop. A stop is also screwed across the end furthest from the operator, to prevent the board K from moving out of its place while its edge is being shot. The shooting-board may be held firmly down to the bench by the aid of a pair of holdfasts. When all is ready, a jack-plane or trying-plane L—either will do—is taken and laid on its side on the bench, so that the cutting-iron is turned towards and touches the edge of the board to be squared up. The plane is then moved along the bench, which can be done easily enough, and the operation of planing the edge is performed with the plane in this position, the side being slid along the bench, which acts as a guide for it. In the same manner, the edge G of the lower of the boards that compose the shooting-board acts as a guide to the sole of the plane.

Its construction and principle.

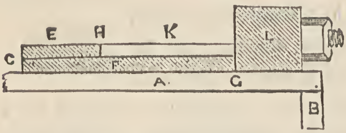


FIG. 239. SECTION OF SHOOTING-BOARD.

501. It will occur to the reader, without doubt, that a shooting-board thus made can only be used for planing boards of a certain width, the width in any case corresponding to that of the rebate formed by the two boards. It is dangerous to attempt to shift the upper and narrower board, lest by any mischance the edges G and H should be rendered not parallel to one another. Here, however, is a hint for a Universal Shooting-board, to suit all widths up to 11in. Let the lower board A in fig. 240 be 13in. in width, and let the upper board B be 2in., so that the difference in their width is just 11in., the width of the widest board usually obtainable in deal. Across the width of A, two, three, or more grooves, C, are cut, according to

Utility of shooting-board limited.

Universal Shooting-board.

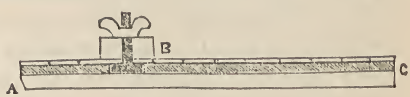


FIG. 240. UNIVERSAL SHOOTING-BOARD (SECTION).

the length of the board, in each of which travels backwards and forwards the square head of a bolt, which is kept in place by two plates or flanges of metal laid over the opening of the groove, at a width apart just sufficient to allow the shank of the bolt to work up and down with ease. The upper surface of each metal plate is graduated in inches and parts of inches. A nut that can be turned with the thumb and fingers passes over the screw-end of the bolt, which passes in its turn through the central line, longitudinally, of the narrow board B. Now it is plain on looking at fig. 241, that the board B, by relaxing the nut or thumbscrew at the upper end of each bolt, can be moved to any distance from the edge C C up to 11in., and secured in that position by tightening the thumb-screws. The metal plates at C, C, being graduated, it must follow that if the board B be correctly set its edges must be parallel with the edge C C, and either side of the board A can be used with pleasure for shooting the edges of other boards. To hold in position the board whose edges are to be planed, a stop may be provided, attached with screws at either end of the board, and so transferable at pleasure.

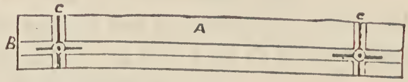


FIG. 241. UNIVERSAL SHOOTING-BOARD. (PLAN.)

Its construction and principle.

502. Before proceeding to what, for want of a better and more appropriate name, we have called the "composite" bench, it is necessary to return for a brief time to the bench-screw. The great evil of the ordinary bench-screw is, that it is apt to get strained, and fails to grip fairly any thick piece of wood, as a piece of quartering, placed between the cheek and the front of the bench. The head of the screw is in the centre and bears directly against the centre of the cheek, and it is not difficult to see that when a piece of wood is put in on one side and the cheek screwed tightly up against it, there will be a tendency on that side of the cheek which bears against the wood to project a little further than the other side, which is pressed inward by the screw-head, but meets with no piece of wood within it to counteract this force and keep the inner side of the cheek parallel in all parts of its surface to the face of the bench front. To overcome this tendency many contrivances have been suggested and brought into use, some of which are well worth our consideration, and which it may be useful to describe here.

Evil of ordinary bench-screw.

503. The most simple means of preserving parallelism between the faces of the bench-front and the cheek of the bench-vice is to be found, perhaps, in the use of a second and smaller screw attached to the bench-

cheek, and passing through the bench-leg opposite to which the cheek is placed, as shown in fig. 242. In this illustration, A represents the bench-top, B the bench-front, C the bench-leg, opposite to which the bench-vice D is placed, E the bench-screw, and F the block which is attached to the back of the bench-leg, and through which the screw works. The smaller screw G, by which the parallelism between the bench and bench-vice is preserved, is fastened immovably to the bench-vice at its head H, and passes freely through a hole bored through the bench-leg at K. The nuts L and M work up and down the screw at the pleasure of the operator. When it is required to move the vice inwards or outwards, it is clear that the nuts must be turned till one reaches the head H and the other the end G of the screw, and that when the cheek of the bench-vice D has been brought inward or outwards to the extent required, the nuts must be again turned in the contrary direction until they are brought against the bench-leg. This necessarily involves a great deal of trouble, and causes a great waste of time. Moreover, a hole must be sunk in the face of the bench-leg large enough to receive the nut M; for if this were not done the face of the bench-cheek could never be brought into close proximity to the bench-leg.

Regulation of parallelism between bench and bench-vice.

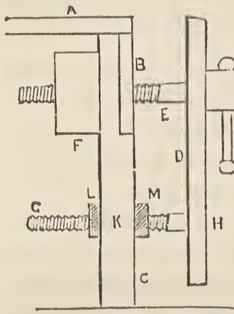


FIG. 242. REGULATION OF PARALLELISM BETWEEN BENCH AND BENCH-VICE.

504. Having now some idea of the broad principle of the method by which parallelism between the bench-vice and bench-leg may be obtained and preserved as long as may be needed, let us turn to another method by which the same end may be attained without the least trouble and loss of time. This ingenious contrivance for keeping the inner surface of the cheek of the bench-vice parallel to the outer surface of the board that forms the front of the bench is the "Croix de St. Pierre," or, "St. Peter's Cross," as it is called on the continent, where it is very generally adopted and used by all carpenters and joiners.

The Croix de St. Pierre.

505. In fig. 243 the Croix de St. Pierre, its manner of action, and the mode of fixing it, is shown in a section of the bench and bench-vice, which affords the most convenient method of exhibiting these points clearly and intelligibly. In this figure, as in fig. 242, A represents the bench-top, B the bench-front,

Its construction and action.

C the bench-leg, opposite to which the bench-vice D is placed, E the bench-screw, and F the block at the back of the bench-leg, perforated by a female screw, in which the bench-screw E works. It will be noticed that in this and the last figure, the cheek of the bench-vice, instead of being about the depth of the board which forms the bench-front or a little deeper, as in the ordinary carpenter's bench, is long and comparatively narrow, extending downwards nearly to the ground. It is, moreover, placed exactly opposite the leg of the bench, so that the bars which form the cross may be conveniently attached to both bench and bench-vice, and work in a suitable manner. The Croix de St. Pierre is nothing more than two flat bars of iron of equal length connected at the centre of each by a pin, G, about which they turn freely. For the reception of the bars, two deep grooves, H and K, are cut in the bench-leg and cheek of the bench-vice, exactly opposite to each other, and of the width of the two bars placed together or just a trifle more. The ends L and M of the bars are fastened by pins running through the bench-leg and bench-cheek respectively. The other ends N and O are left free, and work up and down the bottom of the grooves, which may be lined, if desired, with a piece of iron-plate cut to fit them exactly. Now, as the bars are secured at the upper end of each and fastened together in the centre, it is manifest that they will act in the same manner as a pair of scissors, and that when the ends L and M are pushed apart or drawn together the ends N and O will be pushed apart or drawn together in like manner. When the bench-cheek is close to and touching the bench-front and leg, the ends N and O of the bars will touch the ends of the grooves; but as the screw is turned so as to bring the cheek outwards, the ends L and M are drawn apart, and the ends N and O follow the course of the dotted lines, exerting an outward thrust, the one on the bench-leg and the other on the bench-cheek, and preserving

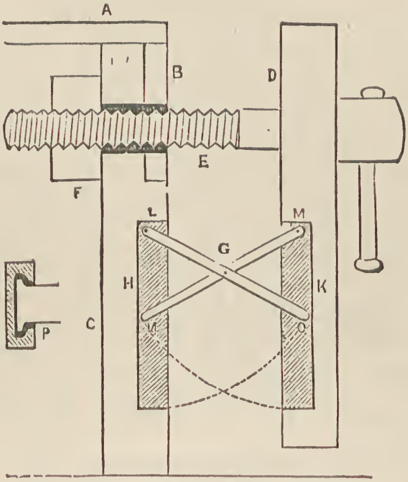


FIG. 243. THE CROIX DE ST. PIERRE.

perfect parallelism between the faces of the two. When the screw is turned in the opposite effect is produced, but it may be necessary to assist the return of the bench-cheek by a little gentle pressure at the bottom, which might be applied with the foot. This would be rendered unnecessary if the free ends of the bars were contrived so as to work in a groove similar to that employed for the rack of a window-blind, and as shown in section at P. This, however, would tend to make the contrivance very costly. I am not aware that the Croix de St. Pierre is made and sold in England. On the continent it costs about 5s., but any blacksmith would make the cross and the irons to line the grooves for less money.

506. Many amateurs will doubtless prefer the broad cheek that extends for about 18in. along the bench-front, and for this reason—that it presents a more convenient shape for holding in a vertical position any piece of wood, especially quartering, at whose ends it is desired to cut tenons. The St. Peter's Cross, however, can be easily adapted to a cheek of this description, and the parallelism can be perfectly preserved by the help of two screws, which can be easily worked at one and the same time by a very simple arrangement. In fig. 244 let A B C D represent the outer face of the cheek, and E, F, the heads of two iron screws cut square, so that the square openings in the arms G, H, may be fitted over them. At the other end of each arm are square projections K, L, over which openings in another plate, M, may be fitted, in the centre of which is a handle, N. Now it is evident that the screws may be turned in or withdrawn at the same time by turning the handle N to the right or to the left as may be necessary, and that by the double screw action the parallelism of the cheek and bench-front will be preserved. To give greater steadiness to the cheek a St. Peter's Cross may be introduced between the cheek and the bench-front in the position shown by the double-dotted line from O to P. It is not, however, a *sine qua non*, as the double screw action will be perfectly effectual in keeping the cheek parallel to the bench-front in all parts.

Broad cheek: why preferred.

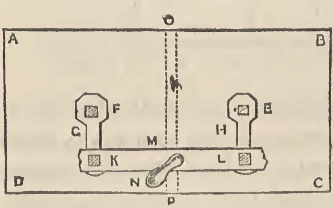


FIG. 244. DOUBLE SCREW FOR BENCH CHEEK.

Mode of preserving parallelism.

507. There are many other contrivances, but none will be found to beat the double screw turned simultaneously in the manner described.

The principle involved in the double screw is made use of to a certain extent in the runner, which, in order to render the description of the carpenter's bench as complete as possible, may as well be noticed here. The object of the runner is to preserve the parallelism of the cheek and bench-front. In fig. 245 A shows the runner and the way in which it is attached to the cheek B. This runner works in a case, formed by the boards C, C, which extend from front to back of the bench and enclose the runner on both sides, keeping it in position. The screw D may also work in a case, whose sides E, E, should just touch the threads of the screw as lightly as possible. An adaptation of the runner to the screw, extending the whole length of the bench-leg or nearly so, is shown in figs. 246 and 247, of which the former shows the end elevation of screw, cheek, runner, and bench, and the latter the front elevation of the bench-vice. The position of the screw in this arrangement is a good one, because more space is given between the upper part of the screw and the top of the bench for holding short boards. The reader must now be so familiar with the component parts of the bench as to render unnecessary any reference in detail to these parts as shown in the figures.

The runner.

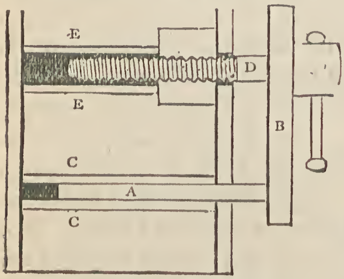


FIG. 245. THE RUNNER.

Adaptation of runner to screw.

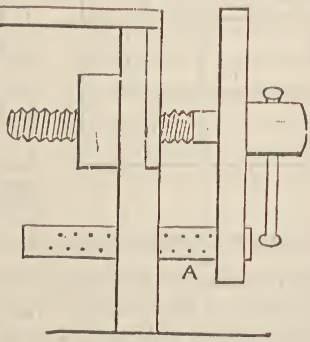


FIG. 246. RUNNER—END ELEVATION.

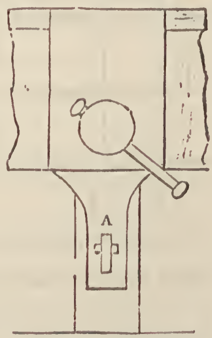


FIG. 247. RUNNER—FRONT ELEVATION.

The runner A is a piece of board let into the lower end of the cheek and passed through a hole cut in the leg for its reception. A series of holes are bored in the runner, and when the vice is screwed up a pin of wood or iron is inserted in the hole that happens to be nearest the leg, to prevent further progress of the runner inwards. It may be

of use to say that all runners should work tightly, but with ease, in the cases made, or holes cut, for their reception, and this effect is best produced by keeping the runners greased. The runner should be made of hard, close-grained wood.

508. A simple but useful kind of bench has been suggested in "Design and Work" for ordinary purposes, which is possessed of much merit, and is evidently the work of a practical man. It is, furthermore, one step towards the construction of the composite bench, with a description of which it is proposed to conclude our remarks on carpenters' benches. The bench now under consideration was the invention of Mr. Joseph M. Laws, of Bridgeton, who estimates its cost at about 5s. or 6s.—a sum which places it within the power of the poorest amateur to possess a carpenter's bench. The plan of this bench, as viewed from the top, and the end elevation are shown in fig. 248. The height of the top from the ground is 2ft. 6in., and the breadth across the top is exactly the same. The length is not stated, but it may range from 5ft. to 7ft., according to the space at the amateur's command in his workshop. A and A are working boards which form the top of the

Laws' bench.

Its dimensions and construction.

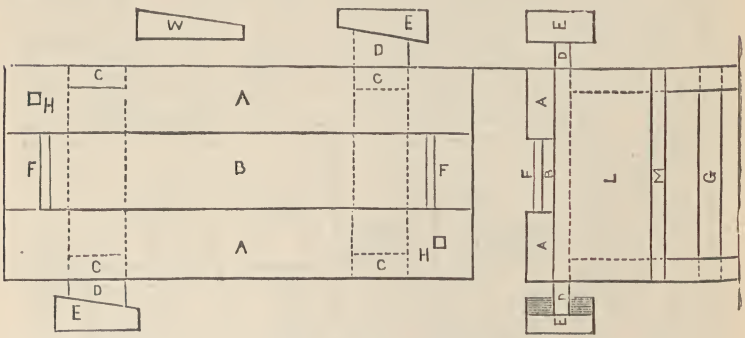


FIG. 248. LAWS' BENCH. (1) PLAN LOOKING UP. (2) END ELEVATION.

bench on either side, and on which all planing, mortising, etc., is done. These boards are 9in. wide and 1½in. thick. The space B between the working boards is fitted in with a board 12in. wide, and ¾in. thick, so that a shallow trench, as it were, ¾in. deep is formed between the working planks, offering a convenient place for laying down tools which cannot possibly fall or be knocked off the bench. F and F are two slips of wood, 1½in. broad and ⅝in. thick, attached to B, and used for resting planes on so that the edge of the plane-iron may not come in contact with the board B below it. H, H, are bench-steps, which

are placed at opposite ends of the working boards, thus rendering the bench reversible, or making it possible for the owner to plane boards, etc., on either side, as he may find most convenient. The legs of the bench, which are 4in. wide and 2in. thick, are shown at C, C, C, C. These legs are connected near the bottom by cross-pieces (G in end elevation) screwed to, or let into, the outside faces, 4in. wide and ¾in. thick, and forming a rack on which pieces of board may be laid. The upper ends of each pair of legs are tenoned into a cross-piece, D, 4in. wide and 2in. thick, the end of which is fitted with a piece of wood, E, 5in. thick, and cut so that its inner surface forms an angle with the bench-front. A wedge, W, 14in. long and 1¼in. thick, is used for jamming a piece of wood against the bench-front when it is necessary to plane its edges, the wedge being driven into the opening at D, between the wedge grip E, and the surface of the board to be planed. The bench-stops H, H, are of the old-fashioned kind, and should be 9in. long, and 1½ in. square. Each side of the bench is covered in with a board ¾in. thick. In this board holes should be drilled for pegs to support boards, whose edges require planing up. The bottom of the bench may be boarded up entirely, or as far as the inner faces of the legs, and if only thus far, boarding should be nailed against these inside faces parallel with the ends of the bench, so as to form cupboards, on either side marked L, for the reception of tools, etc. The door, L, of the cupboard may be hinged to M, and open outwards, thus forming a kind of shelf in front of the cupboard when let down. This cheap and ingenious bench is recommended to the notice of amateurs who cannot afford to spend much in appliances of this kind.

509. We now come to what we have chosen to term the "composite" bench—a bench in which an attempt is made to turn to account every portion of the space that the bench covers, between the ground below and the inner surface of the bench-top. The arrangement of this bench was also suggested by a writer in "Design and Work." Its general construction will be readily understood after all that has been said on the subject, but a few remarks by way of explanation will perhaps be desirable. **The "composite" bench.**

510. This bench (fig. 249) is 6ft. long, 1ft. 6in. wide, and 2ft. 9in. high, and therefore occupies as little space as it is possible for a bench to take up. Six legs are required, 3in. by 3in., which are framed together with rails half the thickness at top and bottom, as shown by dotted lines across the top, at A, B, and C. The bench is fitted in the usual way with a bench-stop at D, and a bench-vice with screw at E, and runner at F, both of which work **Its dimensions and construction.**

through the front leg of the trestle A. The top is formed by two boards 9in. wide, the working board being 1½in. thick, and the board at back 1in. thick, but nothing is gained by this difference in thickness, so the boards may as well, both of them, be 1½in. thick, and joined by a groove and feather slip or dove-tail feather. The side-

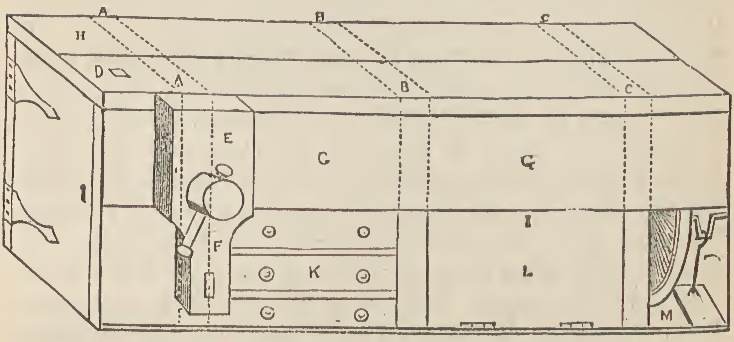


FIG. 249. THE "COMPOSITE" BENCH.

board G is 9in. wide, and 1in. thick and the faces of the legs in front should be flush with the face of this board. The back of the bench should be boarded up, unless it be fixed, as it may be very conveniently, against the wall of a workshop or shed, just under the window. The end H between the trestle A and the end of the bench to the left is converted into a shallow cupboard, which may be fitted with shelves so long as they do not interfere with the screw and runner; but this they need not do, as the screw and runner work in the front leg of the trestle, and can be securely cased in by boards nailed on either side of the trestle. The space K between the legs and trestles, A and B, below the bench-front, is fitted with four drawers, and that between the legs, B and C, at L, is converted into a cupboard with a door hinged at the bottom to let down on the ground. The space between the trestles, A and B and B and C, between the bench-front and the back, by cutting the back board on top, and attaching it to the back of the bench by hinges, may be converted into a well, which will be useful for stowing away planes and other large and heavy tools. The space to the right between the trestle C and the right-hand end of the bench may be fitted up with a wheel and treadle, which might be turned to good account in working a small lathe, placed on the bench, or in turning a grindstone or circular-saw of small size, motion being imparted to the lathe, grindstone, or saw above, by a strap or cord passing round the wheel M, and through holes cut for its

Wheel and treadle.

passage in the top boards of the bench. For the accumulation of power, any contrivance that is worked in this way should be fitted with a fly wheel, which, when the wheel M was put in action, could work over, and parallel with, the right-hand end of the bench.

511. The bench that has just been described is best suited for one that is fixed against a wall, which is the position which in all probability will be most convenient for the amateur artisan, and one which he would prefer to any other. There are, of course, many other ways by which the interior of a bench may be turned to good account, but want of space forbids us to dwell upon them here. Every amateur will doubtless think of some little modification which will render his bench better suited for his own peculiar wants, and when he is engaged in making a bench for himself it will be well for him to exercise his ingenuity in this respect.

Suitable for fixture against wall.

512. The chief objections to the ordinary bench-vice in its simplest form are, that it takes up a great deal of time to adjust and screw up and unscrew the cheek, and that the pressure exerted by the cheek on the board, or whatever else may be placed within its hold, is not uniform at every point of its surface owing to a want of perfect parallelism with the bench-front. The contrivances that have been introduced at one time or other to procure the desideratum of perfect parallelism have been described; but after all there is not one of these that tends to save time by its adoption and use; but rather, on the contrary, some of them cause a still greater loss of time in looking to their adjustment. What is most to be desired, both for working carpenters and joiners and amateurs, is a bench-vice in which the action shall be speedy, the parallelism perfect, and the grip certain, and these requisites are to found combined in the "Standard Instantaneous Grip Vice," a most ingenious invention patented by Messrs. Smith, Marks, and Co., and sold by MR. THOMAS J. SYER, *Cabinet Manufacturer*, the sole agent for London, at whose office and workshops, 1, *Finsbury Street, Chiswell Street, E.C.*, it can be seen in use. An illustration of this vice is given in fig. 250. The workman has simply to raise the lever or handle A to a perpendicular position with the left hand, and draw out or close, as may be necessary, the front jaw B the necessary distance. He must then place the piece of wood, or other material on which he is about to operate, between the jaws B and C, after which he must press the front jaw B nearly close to the wood, then press down the lever, when the wood will be held firm in the vice. To remove the piece of wood he must

Objections to ordinary bench-vice.

Standard Instantaneous Grip Vice.

Its construction and action.

raise the lever as described above. The grip is caused in the following manner. On the under side of the plate, on which the word

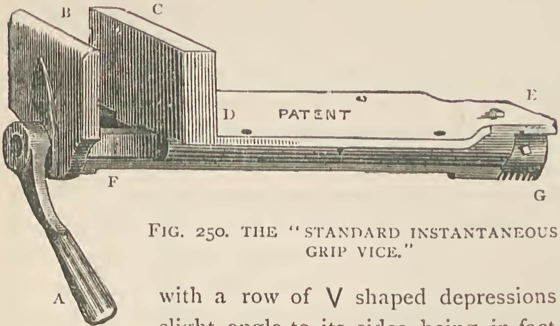


FIG. 250. THE "STANDARD INSTANTANEOUS GRIP VICE."

"patent" is marked in the illustration, and in the straight line that lies between the letters D, E, is a plate indented with a row of V shaped depressions inclined at a slight angle to its sides, being in fact, to describe it as accurately as possible, a longitudinal strip cut out of a female screw. At the end G of the bar F G, which is held in position, and travels in and out between two curved flanges projecting from the under side of the plate, is a short cylinder which is grooved along part of its surface after the manner of the threads of a screw, the remainder being left plain, and carrying a stop or stud which is shown in the engraving, and which prevents the progress of the screw beyond a certain point so as not to cause injury to any substance placed within the powerful bite of the jaws. When the piece of wood, or any other material, as the case may be, has been placed within the jaws, and the front jaw pushed *nearly close* to it, the downward turn of the lever or handle brings the threads of the male screw within the threads of the female screw, and *draws* the front jaw against the wood so tightly, and with so firm a grip, that it is utterly impossible to remove the material without injuring it until the lever is raised and the pressure relaxed. It is the *drawing* action of the screw that gives value to the "Standard Instantaneous Grip Vice," by causing the pressure of the jaws to be brought *gradually*, though swiftly, to the point that is required to hold the material immovable within their grasp.

513. The principal advantages of this bench-vice are: (1) that it grips and relaxes its hold instantly in any distance up to 13½in.; (2) that the action and working of it are so complete that a piece of ordinary writing-paper can be secured and held as firmly as a piece of timber; (3) that it effects a saving of about 75 per cent. of the time employed in working the ordinary bench-vice by its easy action and certainty of its grip; (4) if wood facings are fitted to the faces of the iron jaws all possibility of indentation of the article placed in it is removed; and (5) that it can be fitted to any description

Advantages of grip-vice.

of bench, new or old. The price of the vice is 18s., or if supplied with wood facings fitted to the jaws, 20s. As the jaws are of iron it is evident that the vice will serve the purpose of an iron bench-vice for holding pieces of metal, as well as that of an ordinary bench-vice for holding wood, and that the amateur who possesses one of these has no occasion to go to the expense of purchasing an iron bench hand-vice. By placing within the jaws two pieces of wood of sufficient length to hold a saw, this vice may be further utilised as a saw-vice. Mr. Syer also supplies a most useful article for workmen and amateurs in his "Improved Portable Cabinet Bench," one end of which is shown in fig. 251, from which its general character and construction can be seen. The bench consists of a wooden top fitted with the "Standard Instantaneous Grip Vice," and fastened with screw bolts to metal standards, which give extra firmness to the bench, a matter of great importance to the workman. The price of this bench is £3 5s., but if fitted with a screw-rising stop, 2s. extra is charged. As the top and supports are fastened together with screw bolts, the bench can be taken to pieces at pleasure, and thus is rendered more convenient and handy for packing and removal. Boards can be laid from end to end having their ends supported on the ledges shown at A and B, to serve as places of depository for tools when out of use. The bench is of the ordinary height, the top being 6ft. long, 1ft. 10in. wide, and 3in. thick, and formed of two boards or planks firmly bolted together by three bolts and screws. The great thickness is owing to the necessity of bringing the top of the jaws of the vice level with the upper surface of the bench. If, then, it is desired to fit the vice to an old bench, care must be taken to attach to the under surface of the top of the bench, at the part where the vice is to be fitted, a piece of wood

Its adaptability to various requirements.

Syer's Improved Portable Cabinet Bench.

Its construction and advantages.

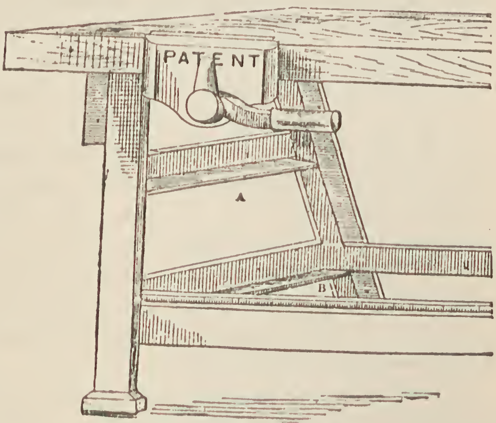


FIG. 251. SYER'S IMPROVED PORTABLE CABINET BENCH.

that will bring the thickness of the top at that part up to 3in. Thus, if the top of the bench be 1½in. in thickness, a piece of equal thickness must be added, and so on.

514. There is another vice similar to the above in general appearance, but differing from it in internal arrangement and construction, which affords perfect parallelism and sudden grasp combined with rapidity of action. This is Entwistle and Kenyon's "Instantaneous Grip Parallel Vice" (Riley's patent), sold in London and the surrounding districts by MESSRS. C. S. MALLET AND CO., 9, *London Street, Fenchurch Street, E.C.*, sole wholesale agents for these parts. They are made in various sizes for engineers with jaws from 3in. to 12in., opening from 3in. to 8½in. The joiner's vice, with which we have more to do at present, and which is well adapted for cabinet-makers, carpenters, amateurs, and those engaged in all kinds of constructive trades, is furnished with 9in. jaws to open 12in., and is sold at 16s. The front jaw is a loose sliding jaw which may be moved inwards and outwards at pleasure; the inner jaw is immovable, and to the bottom of it a steel rack is fastened. Another short steel rack, with the upper surface indented so as to fit into the indentations of the rack fastened to the fixed jaw, is fixed to the innermost end of the sliding jaw. The short rack is thrown into gear with the long rack, at any part of it, when the jaws have been adjusted to the material placed between them, by half a revolution forward of the handle, and this short, quick movement puts the grip on the work. The racks, it should be said, are thrown into gear by means of a scrolled cam attached to the innermost end of the shaft to which the handle is fixed. Half a revolution backwards of the handle brings the short rack out of gear with the long rack, and quite clear of it, leaving the loose sliding jaw at liberty to be moved in or out at pleasure.

Entwistle and Kenyon's Instantaneous Grip Parallel Vice.

Principles of construction.

515. There are two things that yet require mention in this chapter, as, if not forming part of the carpenter's bench, they have a claim to be considered in connection with it. Of these two articles, one is the trestle, or sawing-stool, and the other a means of fitting up and working a small circular-saw, for cutting tenons, and making small saw-cuts generally of this description.

Adjuncts to carpenter's bench.

516. Firstly, let us take the trestle, or sawing-stool. Every amateur artisan should make two of these for himself, as he will often require a pair of them on which to set a long piece of quartering, etc., when cutting mortises in it, or a long board that he is engaged in ripping down with a rip-saw or hand-saw.

Trestle, or sawing-stool.

517. In fig. 252, a trestle, or sawing-stool, is represented in section or in elevation at either end, being the mode of representation best

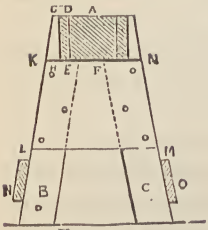


FIG. 252.
SAWING-STOOL. (END.)

Its dimensions and construction.

adapted for showing its construction. A is a piece of wood about 2ft. or 2ft. 6in. long, 4in. wide, and 3in. thick; and B and C are two pieces of wood about 2½in. by 2in., or a little stouter if it be thought necessary. A notch is cut in the upper end of each leg, as at D E F, so that when the legs are placed in the position shown in the drawing, the sides and bottom of the piece A may rest in the notch thus formed, the sides of the notch being at right angles with each other. The notch may be made deeper, as at G H F, to afford a better bed or resting-place for the block A, or the sides of the block may be slightly grooved so that the part G H E D of the leg may be let into the body of block. When four legs of this description have been cut out, and the block grooved, if it be thought better to do so, for the reception of part of the notched ends as described, they must be nailed firmly to the block, two at either end, opposite to one another. To give stability to the trestle, a piece of inch board of the shape K L M N is nailed to the legs on the outside, and two strips lengthwise from leg to leg, as shown at N and O. The appearance of one of the legs at the side is shown in fig. 253, in which A is the block that forms the top as before, C the leg, N M the end showing grain of the piece of wood K L M N, and O the slip nailed from leg to leg on the same side. A stool or trestle thus made is very strong, and will bear plenty of heavy blows and hard usage without being damaged beyond the injury that such knocking about may inflict on the surface. The end of A is often cut as at D E F in fig. 254, the angle D E F being a right angle, or an angle a little less than a right angle. A notch of this kind forms a convenient resting-place against which to rest a piece of quartering for cutting a tenon at the end. Fig. 254 also shows a plan of the top of the trestle at one end; A being the block, and B and C the upper ends of the legs thus lettered in fig. 252, which are let into shallow grooves in A,

Notch in end of trestle.

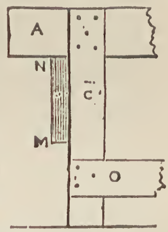


FIG. 253. SAWING-STOOL. (SIDE.)

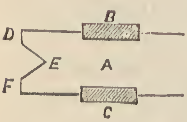


FIG. 254. END OF SAWING-STOOL.

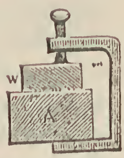


FIG. 255. CLAMP.

as already described. The amateur artisan will find it useful to provide himself with a couple of clamps of the kind shown in fig. 255, for holding down to the stool A any piece of wood that may require mortising, as W. In fact, a couple of small clamps of this kind will be found useful in many an operation in household carpentry and joinery.

Clamps: their uses.

518. Machinery of any kind is a powerful aid to progress in handicraft work of every description, provided always that it be suitable to the nature of the work in hand. All tools are machines, so far that they are *contrivances* by which certain operations can be more effectually performed, though not in the sense in which the word is generally used in the present day, namely, in reference to some complex structure of many various parts. In carpentry, man himself is the motive power of the tools that he employs, and if he be tolerably expert he will be able to get through all work of an ordinary character. He will most crave for the assistance of machinery in sawing and planing; but the attachments necessary for circular-saws are so costly that the tool manufacturer, or rather tool seller, never keeps them in stock; and as for planing machines, they are, as it has been said, out of the reach of the amateur altogether, for they are not only very expensive but require steam power to work them.

Assistance rendered by machinery.

519. For motive power, then, the best thing the amateur can do is to trust to his hands and arms, and back and legs, resting content with the ordinary run of tools. It is somewhat hard, however, to be without a circular-saw, considering the amount of work that may be got through with one of these in a very short space ot time; and the thing now to be considered is how the amateur may manage to fit up a saw that will do light work, and even rip down a piece of board under an inch in thickness.

Motive power for amateurs.

520. Suppose that A B in fig. 255 represents the width of a small bench, showing its transverse section from side to side; or, what is equally to the purpose, let us suppose it to represent the transverse section of a board forming the top of a narrow bench or platform in which the saw is to work. As near to the under surface of the bench as is possible, let there be an iron axle H K, bent at G so as to be turned by the rod N attached to a treadle worked by the foot; and let this axle work at either end in sockets, L and M, fastened to the underside of the plank A, or fitted into the boards in front and at the back of the bench, if the saw be fitted to a carpenter's bench. A small but heavy fly-wheel should be

Mode of fitting and working a circular-saw.

attached to the end H of the axle. Slots must be cut in the board A B —one at C, through which the saw D E may work; and another at F, through which the crank G may work, during its passage through the upper semicircle of its revolution. When the treadle is set in motion with the foot the saw will revolve, increasing in rapidity by the action and weight of the fly-wheel, and requiring less and less pressure from the foot of the operator on the treadle. There would be from one-fifth to one-fourth of the diameter of the saw above the surface of the bench; that is to say, if the saw were 5in. in diameter there might be from 1in. to 1¼in. of its diameter above the surface. It would not be possible to use a saw of any size on account of the power required to drive it, owing to the resistance offered by the wood when it is brought against it, and the friction arising from the passage of the saw through the wood. This is the simplest method of working a small circular-saw. If the operator had some one to help him by turning a handle, it would be possible to impart far greater velocity to the wheel than could ever be attained by the use of the treadle, by means of a series of wheels attached to the side of the bench at B, and acting on a toothed-wheel keyed on to the axle at K, the handle being fixed at some point near the circumference of the largest and last of the wheels comprised in the series, reckoning from the wheel at K as the first. Supposing that there were such an arrangement of three wheels, as shown in fig. 257, in which A is a wheel with ten teeth keyed on to the end of the axle at K, B an intermediate wheel with twenty teeth, and C a third wheel with forty teeth, in the circumference of which a handle D is placed. Now, it is manifest as the number of teeth in C are double those in B, that for every single revolution of C the wheel B will go round twice; and as B has twice as many teeth as A, the wheel A will go round twice for every revolution of B. The wheel A will therefore be turned round four times for every single revolution of C, and the saw, which is keyed on to the axle, like the

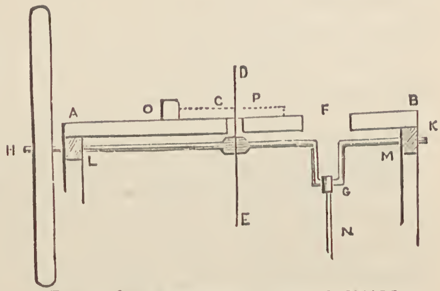


Fig. 256. Method of working small circular-saw.

Multiplication of velocity.

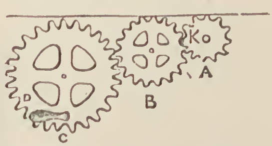


Fig. 257. Multiplication of speed.

wheel A, will also revolve four times. It will be seen that the speed of the saw will depend on the relative number of teeth in the wheels. It is only the principle that it is sought to explain here. The amateur will now be able to work out any combination of wheels for himself.

Guide slip for regulating width to be cut.

521. On looking at fig. 256, it is clear that if a slip be screwed lengthwise to the top of the bench, as at O, in which such a slip is shown in section, and the operator hold a board against this guide slip, as shown by the dotted line at P, also in section, it will be ripped down lengthwise by the saw, and the width of the slip to be cut from the board may be regulated by moving the guide slip to a distance from the plane in which the saw revolves, equal to the width required to be cut. Too much care cannot be taken in making use of a circular-saw. The operator must keep his hands well out of the way, and when the board is nearly cut through, use another piece of board instead of his hands to keep it going in an onward course until the saw has completed its work. For cutting tenons, an arrangement might be made by which the axle of the saw would be above instead of under the bench, but this would be useless for ripping down a long piece of board; and in cutting a tenon it must be remembered that the saw can only penetrate to a depth somewhat less than half its diameter, if the axle be above the bench, for as a matter of course the progress of the wood would be stopped by its coming in contact with the axle.

PART II.

Ornamental and Constructional Carpentry and Joinery.

CHAPTER I.

INTRODUCTORY—ORNAMENTAL CARPENTRY AND ITS VARIOUS BRANCHES.

Grammar of Carpentry—Principles of Construction—Branches of Ornamental Carpentry—Cabinet-making—Turning—Derivation of the Term—General Principle of the Lathe—Various parts of Lathe—Derivation of word "Lathe"—Articles made in Lathe—Fret-sawing or Fret-cutting—Familiar Example—Articles to which Fret-cutting may be applied—Decoration of Flat Surfaces—Ornamentation of Box—Importance of the Work—Effect of Bold Patterns—Meanings of Term "Fret-work"—Wood-carving—Kenilworth Sideboard—Requisites for Success—Carving: what it is—Meaning of Term.

522. WHEN a man knows how to use the different tools employed in Carpentry and Joinery, and has learnt to perform the ordinary operations by means of which pieces of wood are framed together, he may be considered to have become acquainted with what may be termed the *grammar* of carpentry; and, as the simpler processes that come within the province of the house carpenter and joiner are now tolerably familiar to him, he may turn his attention to ornamental carpentry, which involves greater delicacy of manipulation and more careful use of the tools employed, and apply himself to the task of learning the principles of construction comprised in articles of every-day use that he sees about him; and, having learnt how they may be made so as to be as strong and efficient as it is possible to render them, to proceed to the repairing and the making of the articles themselves.

Grammar of carpentry.

Principles of construction.

523. There are various branches of ornamental carpentry or working in wood which present more than ordinary attractions to the amateur artisan, and for whose execution special kinds of tools and implements, and even special machinery, are required. These branches are—

Branches of ornamental carpentry.

1. *Turning;* 2. *Fret-cutting or fret-sawing;* 3. *Wood-carving;* and in one or the other of these, if not in all three, the amateur artisan should endeavour to attain proficiency. He cannot always be exercising his ingenuity as a carpenter in putting up outhouses, sheds, summer-houses, and in making such buildings and other plant that may be required for his various operations in this line out of doors; nor will he continually be able to find scope for his constructive powers as a joiner in making pieces of furniture such as tables, chairs, bookshelves, and book-cases for his house and home, or in repairing damage done to its interior woodwork, and its blinds, locks, and other fittings. In cabinet-making, however, that is to say, in the higher branches of the joiner's art, and in the three kinds of ornamental working in wood specified above, there is always something to be done, either in adding to the furniture already gathered together, or in improving plain pieces of work, or the woodwork of the house, by ornamental additions.

Cabinet-making.

524. Turning may be defined as the *act* of forming solid substances, as pieces of wood, ivory, bone, etc., into different forms by means of a lathe, or of imparting a smoothness and entirely symmetrical form to a metal casting by the same means. Turnery may be taken to mean the *art* of working, as just described, by means of a lathe, or the things or forms which are made by a turner or in the lathe; thus we can speak of a man as being well skilled in the art of turnery, or of the wooden soap bowls, and other articles of a similar kind, sold with brushes, etc., for household use, as turnery.

Turning.

525. The term finds its origin in the word *tornos*, a turner's chisel; whence was formed the Greek verb *torneuein*, to work with a lathe and chisel; thence through the Latin *tornus*, a lathe, and *tornare*, to work in a lathe, or to round off; through the French *tourner*, and the Anglo-Saxon *tyrnan*, we obtain our English word "turn," which is used in other senses than that of working in a lathe, the primary meaning having suggested and brought into use others akin to it in import.

Derivation of the term.

526. The broad principle of the lathe, or turning-lathe, as it is indifferently called, may be described here, the details of its construction and its manifold uses being reserved for the following chapter. From a strong frame called the lathe-bed rises a couple of uprights called heads or poppets. Of these, the one on the left hand is fitted with a mandril and pulley; while the other on the right, generally called the back poppet, is pierced by a long-pointed screw, which can be turned by a bar passing through its

General principle of the lathe.

head like an ordinary bench-screw, or by a wheel with a handle inserted at any point of its circumference, which answers precisely the same purpose as the handle attached to the iron axle of a grindstone, the handle being bent so as to form two arms at right angles to another.

527. Thus in fig. 258, A B is the strong frame that forms the top of the lathe-bed, formed, as shown in fig. 259, of two stout pieces of wood, *a b*, *c d*, bolted together and kept apart by the ends of the uprights C, D, so as to form a long narrow opening or slot in which one or both of the heads may be moved backwards or forwards as may be necessary. **Various parts of lathe.** In the head E is the mandril F, over which passes a pulley G. In the back poppet H is the screw K, turned by the bar L, which passes through its head. The inner end of the mandril is fitted with a screw so as to receive different kinds of fittings, such as a piece of metal fitted with three points to enter into the end of such a piece of wood as M, into the other end of which the extremity of the screw K is forced, the wood being thus held in position. On one side of the lathe-bed and beneath the frame that supports the heads is a wheel N, the axle of which is bent at O, to receive a crank hook P, connected with the treadle Q. A cord passes over the circumference of the wheel N, and the compound pulley E, and by working the treadle Q, motion is imparted to the wheel and pulley, which is communicated to the wood M, which revolves with great rapidity. A tool rest, R, works backwards and forwards along the front of the frame which forms the top of the lathe-bed, and on this, as the name implies, the tool is rested which is used to cut the wood as it revolves. It must be remembered that the foregoing is not so much the description of a lathe as the description of the general principle of its construction, how it is set in motion, and how it acts. It is inserted here to give the amateur mechanic some idea of one of the most useful and important pieces of machinery which is used every day in cabinet-making and ornamental carpentry and joinery.

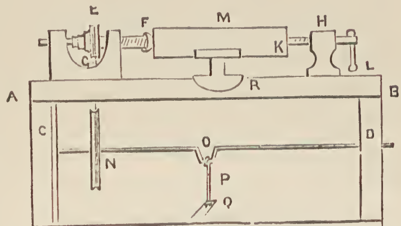


FIG. 258. ELEVATION OF LATHE.

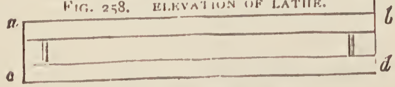


FIG. 259. PLAN OF BED OF LATHE.

528. The word "lathe" is supposed to be derived from the German *lade*—a frame, or that which holds or encloses something else; thus,

bettlade is a bedstead, or the frame on which a bed is supported. It has been suggested that it is akin to the word "ladder," which in itself is a framework of bars, each bar having each end inserted into longitudinal spars which form the sides.

Derivation of word "lathe."

529. From the general description which has been given of the broad principle of the lathe, its uses will at once be made manifest: bars, pillars, whether long or short; the legs of chairs—that is to say, if they are straight; knobs for handles of drawers and doors, pedestals for lamps, and an infinite variety of articles which it would be long and tedious to enumerate, can be easily and quickly made. The manufacture of such articles as these involves the use of both mandril head and back poppet, as it is necessary to support both ends of the wood to be operated upon; but in turning such an article as a bowl, the wood is fastened on one side only to a suitable chuck, which in its turn is screwed on to the mandril. It will be noted that the wood to be turned revolves with the mandril and pulley, becoming, as it were, merely a prolongation of the mandril: the screw that passes through the back poppet is immovable, and the wood into which it is forced revolves freely about its point. It will also be noticed that the axis of the mandril and that of the screw of the back poppet must of necessity be in one and the same straight line.

Articles made in lathe.

530. We will now pass on to a consideration of the second kind of ornamental carpentry, namely, fret-sawing or fret-cutting, in which an amateur may attain excellence with a far less expenditure of time than is necessary to excel in turning, and by means of which he may lend to many articles of furniture or household fittings that are plain in themselves, a highly ornamental appearance and character. A familiar exemplification of fret-cutting may be found in the perforated woodwork lined with coloured silk that forms the front of that part of a cottage or upright piano, which is immediately above the key-board, and against which the cover of the key-board rests when it is raised in order to play on the instrument. As in the case of turning, the description of the tools and manipulation required will be reserved for another chapter. Our purpose in mentioning these branches of ornamental carpentry here is to point out to the amateur how he may make this handicraft peculiarly useful in a decorative point of view if he chooses to adopt it and follow it up. Fret-work in itself is strictly ornamental in character, and can only be applied to decorative purposes. Brackets, paper-cases, book-stands, and a variety of small pieces of ornamental furniture of this kind can be

Fret-sawing or fret-cutting.

Familiar example.

Articles to which fret-cutting may be applied.

adorned most effectively by fret-cutting ; and the raised rim that usually surrounds three out of the four sides of each shelf of the whatnot or wagonette ; and the thin boards by which the Canterbury or receptacle for music is usually divided into narrow compartments may be enriched by this kind of decorative work.

531. There is, however, another purpose to which fret-work may be applied which seems to have escaped notice, though it is specially adapted to the requirements and powers of amateurs. This is the decoration of flat or plane surfaces by raised work. It is, in fact, what is usually called diaper carving, but done by means of the fret-saw instead of in the ordinary way with V chisels, gouges, etc., and any pattern, however elaborate, may be executed thus with this advantage, that the ground-work on which the pattern appears in relief will be smooth instead of rough, as it must be when the wood that has filled up the parts between the pattern is removed by cutting with a sharp instrument. Let us, for instance, suppose that it is desired to impart an ornamental character even to so simple an article as an ordinary rectangular box. The sides of the box having been stained, pieces of thin wood of the size of the ends, front, and top should be taken—and for the back, too, if it be considered necessary to extend the ornamentation to this side of the box—a suitable pattern marked out on them, and the pattern produced by cutting out the interstices by the aid of a fret-saw. As piece after piece is finished it must be attached to the box by means of glue and brads, and the whole of the work, when the attachment of the fret-work is complete, stained, sized, and varnished. There is no absolute need to stain the sides of the box before the fret-work is applied, but by doing so the colouring of the entire surface below is insured, and if any part of the fret-work is accidentally broken off, the injury is not so conspicuous when the surface has been previously coloured as it would be if no staining had been applied until the fret-work was secured in position. The importance of this kind of decorative work—and, as far as we are aware, this is the first time that the adaptation of fret-work to this species of ornamentation has been described—will be readily seen and acknowledged when it is considered what a wide field is opened up for the adornment of such pieces of furniture as chests of drawers, the flat sides of book-cases, book-shelves, etc., which up to this time may have been regarded as incapable of decoration in an effective and suitable manner. The effect of a bold pattern of flowers and foliage conventionally treated on a skirting-board or any narrow pro-

Decoration of flat surfaces.

Ornamentation of box.

Importance of the work.

Effect of bold patterns.

jecting surface, and the enrichment of panels deeply set in the surrounding framework with diaper extending over the entire surface, or a border next to the framework, with a monogram or some other figure in the centre, may be readily conceived.

532. Fret-work in the Arts has two different meanings : it is applied, on the one hand, to work that is produced by cutting or wearing away as by the action of a saw ; and, on the other, to raised or embossed work such as is obtained in embroidery by means of a needle. It is in this sense that the poet Spenser speaks of one

Meanings of term "fret-work."

"Whose skirt with gold was fretted all about."

In this sense the word fret is to be traced to the Anglo-Saxon *frätu*, "ornament," or *frätvjan* to adorn ; but in the sense in which it is used in the term fret-cutting it is akin to the Anglo-Saxon *fretan*, to eat or gnaw away, and the French *frotter*, to rub, which is derived in its turn from the Latin word *fricare*, to rub. In Architecture a fret is an ornament consisting of fillets intersecting each other at right angles, while in Heraldry it is a bearing of bars crossed and interlaced.

533. The highest branch of the entire art of working in wood is undoubtedly that of wood carving, for in order to arrive at any eminence in this noble decorative work it is necessary that a man be a genuine artist and not a mere artisan. Of course we are not speaking of the ordinary carved work that is exhibited on the bowed legs of chairs and other parts of household furniture, as the curved and boldly projecting legs or leg of a console table, the claws of a round or oval table that is supported on a central pillar, or the hideous scroll-work in distant imitation of foliage that often disfigures the frame of a pier glass ; but of the fine copies of still life that were produced by the chisel of Grinling Gibbons ; the elaborate panels and decorations of the Kenilworth sideboard, one of the most notable features of the Great Exhibition of 1851 ; the thrones of the bishops in many of our cathedrals, and the carven screens that adorn many of our village churches. To excel in such work requires time, patience, and abundant practice, and, as it has been said, the spirit and feeling of a true artist. Much, however, may be done in a humbler, less ambitious way, and the amateur need not despair of turning out work sufficiently good and appropriate for the adornment of his home. It is a pleasant pursuit, anyway, and perseverance in the prosecution of any art never yet failed to bring its own reward.

Wood carving.

Kenilworth sideboard.

Requisites for success.

534. Carving is the art or act of cutting wood or stone in a decorative manner, and a carver is one who cuts wood or stone in such a manner. Our English word "carve" is closely allied to the Dutch *kerven*, and the German *kerben*. It differs but very slightly from the Danish *karve*, and owes its parentage immediately to the Anglo-Saxon *ceorfan*. Its meaning is "to make or shape by cutting." He who carves in stone, if he have attained eminence in his art, is usually termed a sculptor, but the man who simply chisels a stone into any given shape is called a carver. There is no distinctive name for the artistic carver in wood, he is only known as such, be his work ever so beautiful and true to nature.

Carving: what it is.

Meaning of term.

CHAPTER II.

THE TURNING LATHE, AND HOW TO USE IT.

Definition of Turning—What a Lathe is—The Turning Lathe—Purport of instruction here given—Description of simple form of Lathe desirable—Pole Lathe, the simplest form—Construction of Pole Lathe—Manner of working Pole Lathe—Disadvantages of Pole Lathe—"Dead-centre" Lathe—Construction of Dead-centre Lathe—Left-hand Poppet—Right-hand Poppet—Communication of Motion—Tool Rest—Capabilities of Lathes described—The Foot Lathe—Driving power—Working of Lathe not difficult—How to understand description—Standards or Supports—Cranked Shaft—Treadle Shaft and Board—Cone Pulley—Bed of Foot Lathe—Cone Poppet and Fittings—Screw Poppet and Fittings—The Rest Plate—How held in any position—Communication of Motion to Mandril—Cone on Cranked Shaft—Revolutions per minute—Variation in speed: how effected—Best speed for Lathe—Communication of motion to work by Chucks—Horned Chuck—Spiked Chuck—Taper Screw Chuck—Disadvantages of these Chucks—Split Chuck—Face Plate—Turner's Cement—How to use Turner's Cement—Another means of Turning without Holes—Chucks described sufficient for ordinary purposes—Home-made Chucks—Tools used by Ornamental Turner—The Gouge—The Flat Chisel—The Diamond Point—Cranked Tool—Management of Tool Rest—Turning down to certain size—Bow or Half-moon Callipers—Hole and Socket Callipers—Oil-stone indispensable—Finishing with Glass Paper, etc.—First efforts in Turning—Tool Handles—Higher Branches of Turning—Spinning Top—Steam Cylinder—Leg of Table—Top of Table—Prices of Lathes, etc.—Second-hand Lathes—Price of good Working Lathe—Prices of Buck's Lathes—Melhuish's Lathes—Turning Tools—Special Lathes for Amateurs—Improved Eureka Lathe—Attachments for Eureka Lathe—Amateur Chuck—Prices of Eureka Lathe—Why well adapted for Amateur—American Hollow Spindle Lathe—Extra Pieces supplied with Lathe—Prices of Lathe and Extras—Ordinary T Rest—Principle of Slide Rest.

535. TURNING may be defined as the art of giving a circular shape and form to articles of various kinds required for different purposes.

Definition of turning.

This is done in a machine called a lathe, so called, as it has been said, either from the German *lade*, which means "a frame which holds or encloses something else;" or from its being a construction of bars and rods in the sense of the word "ladder," an article

What a lathe is.

of every-day use, consisting of two long poles or spars connected at intervals by spokes placed transversely to the poles. A lathe may be taken to mean a contrivance whereby a circular shape is imparted to any article, in which sense the potter's wheel

is a description of lathe by aid of which, by the action of centrifugal force or plastic clay, a round form is imparted to cups, bowls, etc.

536. There are a great number of lathes distinguished by different names, but the one with which we are more particularly concerned is the "turning lathe," which is especially adapted for turning wood. The turning lathe may be described as a machine for giving a piece of wood swift circular or rotatory motion about a fixed axis, various cutting tools being applied to the surface of the article while it is in motion in order to bring it to the required form. We shall first of all describe two of the most simple varieties of the lathe, namely the *pole lathe* and the *foot lathe*, with their constituent parts; and then proceed to notice the appliances and tools used in turning and the mode of using them, concluding the chapter with mention of some of the most handy forms of the lathes that have recently been introduced for amateurs' use.

The turning lathe.

537. It must be remembered that in this work no attempt is made to lead the amateur to the higher branches of the art of ornamental carpentry. It is sought only to tell him what machinery and tools to buy, and how to use them, and having brought him to the threshold, as it were, of this most pleasing method of working in wood, to leave him to make his way onward and upward in a branch of constructive art on which volumes have been written without exhausting the subject or even wearing out its freshness.

Purport of instruction here given.

538. The description of the simple forms of the lathe in the most minute particulars will be of advantage for several reasons. In the first place, the expense involved in purchasing a lathe of the better kind may deter many from getting one at all, unless they know that it is possible for them to avail themselves of a cheaper contrivance; secondly, some amateurs may already be possessed of one, but may not know how to use it; and, thirdly, some may desire to make their own, but perhaps have not sufficient mechanical skill to construct any but the simplest. In either of these cases the description will be of service, while to those who are able to buy or perhaps construct a more efficient lathe, it may be useful in bringing under their notice some point or other in connection with the lathe which had escaped their attention.

Description of simple form of lathe desirable.

539. The *pole lathe* and the "*dead-centre*" *lathe* are, as it has been said, the most simple forms of this useful contrivance, but of these two the pole lathe is certainly the more simple in its construction, and the less convenient and effective in

Pole lathe, the simplest form.

its action. A description of this lathe shall therefore be first placed before the reader.

540. The pole lathe, which is represented in fig. 260, consists of a table or bench of substantial construction, having a slot cut in it from side to side, as shown in the drawing. This slot is intended for the reception of two upright pieces of wood, one of which, A, is placed at the left-hand end of the slot, while the other, B, can be moved backwards and forwards as may be necessary, and fixed in the position required by a screw underneath the table or bench which clamps it to the under-surface of the table-top. Each of these pieces of wood, or "poppets," as they are technically termed, has a piece of iron, pointing inwards, fastened to it, as shown at C and D, these irons being pointed at the extremities, and between these points or centres the wood to be turned is placed, as E. There is a treadle, F, underneath the bench through which the end of a piece of cord or thick catgut is passed and secured. The cord is then twisted several times round one end of the work as at G, and the other end fastened to an elastic beam or *lath* (whence, perhaps, the name lathe) fixed in a convenient position above the bench as at H. It will be noticed that the poppets are made in such a way as to present shoulders or ledges as at K and L, which project over the surface of the bench towards the operator. On these ledges or notches a long straight piece of iron is laid, which serves as a rest for the cutting tool during the progress of the work.

Construction of pole lathe.

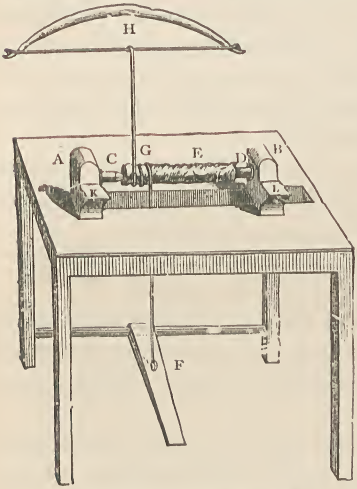


FIG. 260. THE POLE LATHE.

541. The manner of working the pole lathe is as follows :—Depress the treadle with the foot : it will be found that this movement draws down the cord, and causes the work to revolve. Then, while in the act of depressing the treadle, apply the tool, which will be either a chisel or a gouge, to the work. When the treadle is at its lowest remove the weight of the foot, and the elasticity of the lath or bow overhead will cause the treadle to return to its original position, ready to be again depressed. It will be noticed that the driving cord is wound round the piece of wood to be

Manner of working pole lathe.

turned. The piece of wood that is to be operated upon must therefore of necessity be much longer than the article that is to be turned, which will be cut out of the wood within the points D and G. The utmost care must be taken to keep the cutting tool clear of the cord. It will also be noted that when the treadle is depressed the wood will revolve in a direction *towards* the operator, *meeting the edge of the cutting tool*, and it is only while the wood is rotating in this direction that the cutting tool can be applied to its surface. When the pressure of the foot is withdrawn and the treadle is ascending, the wood will revolve in the contrary direction; and until the pressure of the foot is again applied to the treadle, the cutting tool must be removed or slightly drawn back from the wood.

542. The necessity that there is for removing the tool from the wood during every back stroke or counter-revolution of the wood is of course a great inconvenience, and some sorts of work cannot possibly be turned in the pole lathe. Another detriment lies in the fact that the upward and downward strain of the cord has a tendency to pull the wood out of the centres, or to break it in two if it has been found necessary by reason of the pattern to cut very deeply into it. The extreme simplicity of this form of lathe is its greatest recommendation. It is said to be much used by the London alder turners, but very seldom by amateurs, although even this lathe is much better than none at all.

Disadvantages of pole lathe.

543. The amateur artisan will find the "dead-centre" lathe much more convenient and in every way better suited for his purpose than the lathe which has just been described. The advantages that the "dead-centre" lathe possesses over the pole lathe are, that no gut or string is required to be wrapped around the work, thus the whole surface of the wood to be turned can be operated upon without the hindrance or inconvenience that the use of the cord entails, the rest on which the cutting stool is supported can be more advantageously placed, and the tool can better be brought to bear upon the work.

"Dead-centre" lathe.

544. The "dead-centre" lathe, which is shown in fig. 261, consists of a bed A, formed of two pieces set lengthwise and bolted together so as to leave a space between them. Upon the bed are the two poppets B and F. The poppet B to the left hand is immovable, and can be made use of as a means of preserving the necessary space between the two pieces of wood that form the bed of the lathe, the bolt M passing through the neck or shank of the poppet as well as these timbers. At the other end, beyond the

Construction of "dead-centre" lathe.

part that is represented as broken off in the engraving, a piece of wood the thickness of the neck of the poppet B must be inserted. The timbers placed lengthwise, the poppet B, and the piece of wood introduced between the timbers at the other end, form together a solid framework, with a long narrow slot in the middle, up and down which the poppet F can be moved, and fixed at any required place along the bed to suit the lengths of different pieces of work. To the inner face of the poppet B a piece of iron D is fastened,

Left-hand poppet.

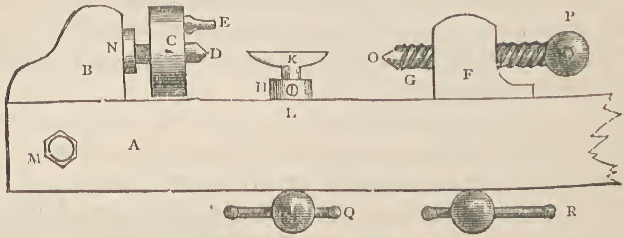


FIG. 261. "DEAD-CENTRE" LATHE.

by means of screws passing through the disc or collar N. The extremity of this iron is pointed, as shown at D in the illustration, and over it passes a small round pulley C, furnished with an iron pin E. The pulley C when set in motion will revolve freely round the iron D, which serves as a spindle for this purpose.

545. The poppet F, to the right hand, is also made of wood, and through it passes an iron screw G, with its ends pointed in the same manner as the iron D. The wood to be turned is put between the centres D and O, the extremities of the iron D, and the screw G, the right-hand poppet F is fixed at a convenient distance from the left-hand poppet B, according to the length of the work; the screw G is then screwed up by means of a handle passing through its head P, so as to force the sharp points or centres, D and G, into the ends of the wood, the end of the iron peg E entering into a hole bored for its reception in the end of the wood next to the pulley C. If, however, the end of the peg E does not project beyond the point D, but is shorter than the spindle on which the pulley C turns, a nail, or something of the sort, must be driven into the wood in such a place and of such a length as will catch the iron pin E of the pulley. Motion is communicated from any convenient motive power to the pulley by means of a belt. The most convenient will be found to be a wheel under the bed of the lathe, and immediately under the pulley C, set in motion by a crank-axle and treadle. The tool-rest is in two parts, the holder H, and the

Right-hand poppet.

Communication of motion.

rest or support K, both of which are made of iron. The holder H can be moved anywhere along the work, or farther from, or nearer to, the work, and can be fixed firmly in any required place by the screw Q below it, in the same way as the poppet F is fixed by the action of the screw R. The rest K fits in a socket of the holder, and can be raised or lowered, or set at any angle that the shape of the work renders desirable or necessary, being held firmly in the position required by tightening the screw L.

Tool-rest.

546. It is not possible in either of the lathes that have been described to turn any article unless it be supported at both centres; thus, for example, it is possible to turn a pillar or a ball, but any hollow object, such as a bowl, cannot be turned in lathes made on the principle of the pole lathe and "dead-centre" lathe. Now the amateur may often require to turn flat objects, such, for example, as a bread-platter, or the top of a small table, where it is inconvenient to support it between the centres. For anything of this sort neither of these lathes would be of the slightest use; there is, indeed, a modification of the first that admits of such things being done, but at such an expenditure of time and trouble as to render it a hopeless task for the amateur to perform.

Capabilities of lathes described.

547. This is a very serious drawback, but the attention of the amateur artisan is now invited to a lathe which has not this fault, and which is, in fact, a better lathe in every respect. Figs. 262 and 263 represent the front and side elevation, and fig. 264 the plan of this lathe, which is called the "foot lathe," partly because it is driven by the foot, and partly to distinguish it from others. It is almost unnecessary to remark that where steam or other power can be obtained it is far preferable to the treadle, and can be easily applied so as to work the lathe without the operator having to exert himself in the slightest degree. Few amateurs, however, will be able to apply any driving power to the lathe, other than that which can be obtained from using the legs. Having to tread is, at the best of times, somewhat of a nuisance, and the amateur will at first have some difficulty in preventing the treading motion of his leg from influencing his whole body; that, however, will be soon got over by practice, but if the article to be turned is large it is rather hard work to turn and tread also.

The foot lathe.

Driving power.

548. Treading is capital exercise for the legs, and it is not a whit more difficult to work a lathe in this manner than a bicycle, and of the two the latter is likely to prove the more fatiguing. When one leg is tired, the operator should make the other take its turn at treading

work; and if the article be very delicate it is advisable that some other person should tread while the amateur turns. The foot lathe being one of the best forms of lathes for turning wood, the description will be entered into more minutely than that of those previously mentioned. In the various representations of this lathe from different points of view in figs. 262, 263, and 264, which are respectively the front view, top view, and side view, the same letter is used to denote the same part; should the reader, therefore, not exactly understand any particular part, he may look at the part indicated by the same letter in each of the three illustrations, by doing which, any possibility of not comprehending what is said, will, in all probability, be entirely obviated.

Working of lathe not difficult.

How to understand description.

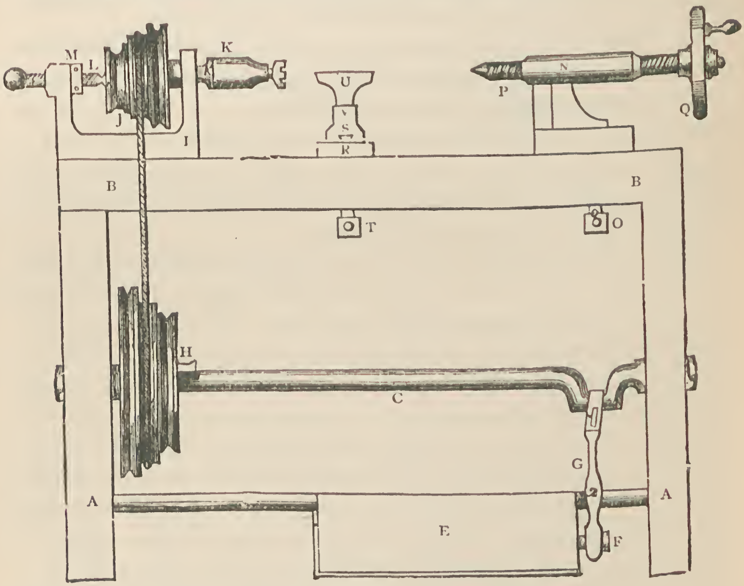


FIG. 262. THE FOOT LATHE (FRONT VIEW).

549. To commence at the foundation, the standards or supports A are generally made of cast iron: sometimes they are made of wood, but if of the latter material they must be made much stronger and stouter than represented. These standards carry the bed B, to which they are firmly bolted, and between them they also carry the cranked shaft C, and the treadle shaft D. The cranked shaft C is made of wrought iron; it works in collar necks and bearings. The treadle shaft D is also made

Standards or supports.

Cranked shaft.

of iron, and is capable of being moved freely in holes made in the standards. Fastened to this shaft is the treadle-board E; this is furnished with a wrought-iron pin or stud F, to which the connecting rod G is attached, passing at the other end over the

Treadle shaft and board.

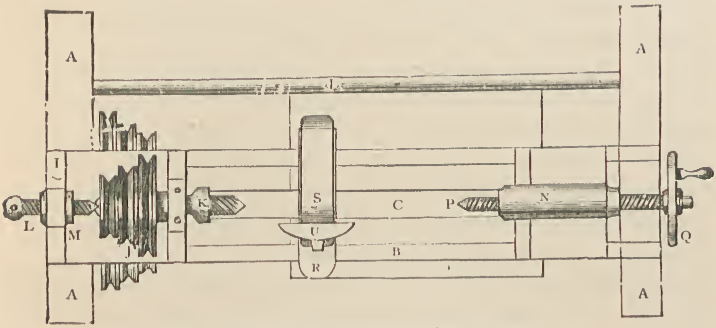


FIG. 263. THE FOOT LATHE (TOP VIEW).

crank in the cranked shaft, and enabling any one, by pressing one foot on the treadle-board E, to set the cranked shaft in motion. Immovably keyed upon the cranked shaft is a heavy wooden cone pulley H. Although the steps or speeds of the cone pulleys are generally flat and driven by a flat leathern belt, it is found that for light lathes a V grooved pulley driven by a round cord is preferable, and is often used.

Cone pulley.

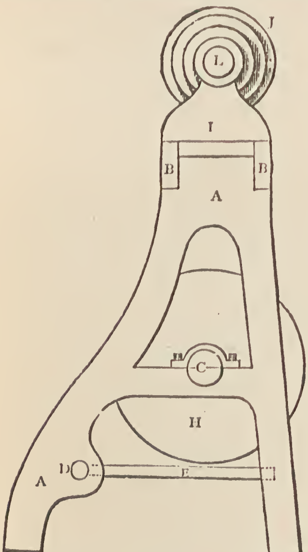


FIG. 264. THE FOOT LATHE (SIDE VIEW).

550. The bed B is generally of cast iron, but it can be made either wholly of wood, or partly of wood and partly of iron, by—in the latter case—fastening a flat strip of iron on the top of the wooden slabs. Of whatever material it is composed it is essential that the top surface should be perfectly straight and level, and be scrupulously kept so.

Bed of foot lathe.

551. Bolted firmly to the bed is the cone poppet I, which should be made of cast iron. The cone J may be made of wood, iron, or brass. Although brass *looks* the best, it is generally agreed that wood *answers*

the best : it is not of course so durable, but it is lighter and conse-

Cone poppet and fittings.

quently does not take so much power to drive it ; the cord also *grips* firmer to wood than to metal. The speeds and grooves are made to correspond to those of the cone pulley H. The cone J is immovably fastened to the mandril K, which is made of either iron or steel, and is turned to run in a bearing in front of the cone poppet. Behind it is furnished with a conical indent or female centre, which runs on a steel-pointed centre screw L. The other end of the mandril has a screw-thread cut upon it, and is terminated by a sharp point or centre. The centre screw L is made of iron or steel, and has a point or centre at one end, and a round ball or nut at the other ; it screws through the cone poppet, and is kept from either screwing or unscrewing by tightening the lock-nut M.

552. The screw-poppet or right-hand poppet N is also made of cast iron, and can be moved anywhere along the bed B, and fastened firmly

Screw-poppet and fittings.

when and where required by tightening the screw O. Through this poppet there is a hole fitted with an internal or female screw made of wrought iron or steel, cut with a thread capable of receiving the screw P, which passes through it, and has at one extremity a sharp front or centre, and at the other an iron hand-wheel Q. By turning this wheel forward the centre or sharp point of the screw P approaches nearer the other poppet, and by turning it the contrary way it recedes from it.

553. The rest-plate R, which is made of iron, can be moved up and down anywhere on the bed between the two poppets. The little piece

The rest-plate.

S is the rest-holder : it is made of iron, and has a V groove cut along its bottom ; it can be moved in or out, nearer to, or farther from, the work. Both the rest-holder and plate can be

How held in any position.

firmly held, where for convenience it is required, by tightening the headed screw T. This screw is made of iron, and is in two parts ; one part has a head the same shape as the groove in the rest-holder, and also has a thread cut upon it to fit into an internal thread cut in the lower part or nut of the screw. The tool-rest U is made of iron, either wrought or cast, but generally the former ; it has a round shank which fits into a socket in the holder. The rest can be raised or lowered in the socket, and set at any convenient angle ; it is firmly fixed at the required position and height by tightening

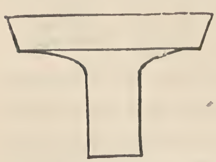


FIG. 265. FRONT VIEW.

FIG. 266. SIDE VIEW.

THE REST.

the screw V. Enlarged views of the rest as it appears when looked at from the front and side, are given in fig. 265 and 266 respectively.

554. It now remains to show how motion is given to the mandril K, and consequently to the work. The operator stands in front of the lathe, generally with his right foot on the treadle board E. The board must be depressed, and directly it comes to the bottom the weight of the foot must be removed from the board. The "fly," or momentum of the pulley H, will carry the crank over the "dead centre," and will raise the treadle to be again depressed with greater force until the cranked shaft comes up to speed. The circular motion of the cranked shaft is communicated to the mandril by a cord or gut passing over both pulleys.

Communication of motion to mandril.

555. The cone on the cranked shaft is generally of a larger diameter than the mandril cone, the former often being five or six times as large as the latter. This is done to increase the speed : thus, supposing the large cone to be five times the size, or to have a circumference equal to five times the circumference of the mandril cone, then every one hundred revolutions of the cranked shaft will make five hundred revolutions of the mandril. It is generally allowed that one can conveniently, and without great exertion, tread about eighty or one hundred times per minute, now the cones are made in steps, so as to alter the speed of the mandril whilst the crank-speed remains constant ; thus, when we wish to increase the speed, or drive at the highest speed, the gut or cord is put on the largest speed of the cranked-shaft pulley and the smallest speed of the mandril pulley ; and when it is wished to decrease the speed to a minimum, the cord should be on the smallest step of the cranked-shaft pulley, and the largest of the mandril pulley ; and the intermediate speeds the same, the cone pulleys being made of such a size that the relative proportions of the cones can be altered without tightening the belt.

Cone on cranked shaft.

Revolutions per minute.

Variation in speed: how effected.

556. Wood differs so very much in density, grain, etc., that it is impossible to give the speed at which it should be turned without seeing it, but the amateur turner need be under very little apprehension of running his lathe too fast. As a general rule, however, it may be observed, that the *best* speed is the fastest at which it can be turned without blunting the tools too much. When a lathe is driven from a shaft by steam or other power, there is more chance of overdoing it with regard to speed, because it is quite possible to drive even so soft a substance as wood fast enough to cut or rub the steel tool instead of the tool cutting the wood. The speed should

Best speed for lathe.

seldom exceed 500 circumferential feet per minute—that is, supposing the article to be 1ft. in circumference, it should revolve five hundred times in a minute. This must not, however, be considered an arbitrary rule. The amateur artisan, by the exercise of a little observation and judgment, will very soon be able to tell the proper speed for any kind of work; indeed, an experienced workman can tell at a glance, before touching it with the tools, whether it is at the right speed or not.

Communication of motion to work by chucks.

557. We now know how to obtain the circular motion with the lathe, but it remains to communicate this motion to the work. There are several methods of doing this, but it will be sufficient to show some of the best and most frequently used of them. It is done by means of different sorts of instruments called "chucks" which are screwed to the mandril.

Horned chuck.

558. The horned chuck, shown in fig. 267, is used for long and small things; it is screwed into the screwed end of the mandril K of the foot lathe. One end of the wood is placed against the chuck, the right-hand poppet is then drawn up against the other end of the wood and firmly fastened to the bed; the hand-wheel is then turned forward so as to force the jaws of the chuck into one extremity of the wood, and the centre into the other. It is essential that both the chuck and the centre should be in about the middle of the wood, otherwise it will necessitate the turning off of so much more of the wood from one side than from the other before it will be round; and, if the rough wood is not a great deal larger than the finished article is required, it will not hold up to size.

FIG. 267.
HORNED CHUCK.

FIG. 268.
SPIKED CHUCK.

Spiked chuck.

559. The spiked chuck, of which the disc is shown in fig. 269, and the side view with the spikes projecting from the disk in fig. 268, is useful for turning a rather large flat piece of wood, or a large and long piece. In the former case the chuck is screwed on the mandril end, and the wood placed against it and gently tapped until the spikes are embedded in the wood, and the face of the wood is close against the flat part of the chuck. It is advisable that one surface of the wood, that which is to bear against the chuck, should be planed true, or nearly so, before it is put on in

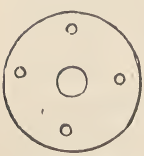


FIG. 269.
SPIKED CHUCK.

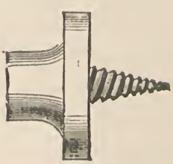


FIG. 270.
TAPER-SCREW CHUCK.

place. The centre is not now required. In the latter case one extremity of the wood is forced on to the spikes, and the right-hand poppet brought up and the centre forced into the wood in the same manner as before described.

560. The taper-screw chuck, shown in fig. 270, is a very useful chuck; it is used entirely for short work. The chuck is screwed on the mandril end; a hole is made in the centre of the wood of the same size as the smallest part of the screw, and rather deeper than its length; the hole is applied to the point of the screw and held there whilst the lathe is pulled round slowly with the left hand. The wood will then be screwed up against the flat surface of the chuck, and will remain there firm enough to be turned. If it is wished to screw the work on the opposite side, so as to be able to manipulate the unturned portion, a hole similar to the one already made must be cut out in this side whilst the work revolves. The wood can be then unscrewed and put on the other side. If this hole be cut or turned out true, that portion of the article which has already been turned will run true when so changed sides with.

Taper-screw chuck.

561. The fault in both the spiked chuck and the taper-screw chuck is that the spikes in the one, and the screw in the other, disfigure and injure the face of the work. For most things, or for patterns, this is of very little consequence, because the holes thus made can be stopped with putty; but for some ornamental articles these marks or disfigurations would be exceedingly objectionable, because they could not be putty-stopped well enough to prevent their being noticed. Therefore, when the amateur artisan has occasion to turn anything of that sort, if small, he should use the split chuck, shown in fig. 271. The article can generally be partly turned more conveniently in one of the other chucks, and such portions in them as cannot be done without injury turned in this one. The split chuck can, however, be used for many other purposes.

Disadvantages of these chucks.

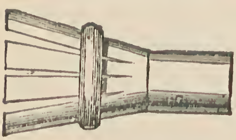


FIG. 271. SPLIT CHUCK.

Split chuck.

562. If the article is large, the face-plate shown in fig. 272 is screwed on to the mandril end, and the article stuck to the plate with Turner's Cement.

Face-plate.

Recipe for Turner's Cement.—Take of resin four parts and of pitch one part; set these ingredients by the fire to melt in an old pan or earthen pipkin, and when the mixture is liquid stir in sufficient finely powdered brick-dust to make it a stiff paste.

Turner's cement.

563. The cement must be placed hot against the face-plate, and the work pressed against it. When cold it will hold the wood to the plate sufficiently firm for the article to be carefully turned ; and, when finished, a gentle blow will detach the work from the plate. The cement should be taken care of, because it can be used almost any number of times ; but it must be warmed each time before it is used. When using the cement, the amateur artisan must take great care to lay it evenly on the face-plate, and not put it on thicker at one place than at another. The obvious effect of his not taking this precaution is that his article will be of unequal thickness, and consequently spoiled. Should this cement not be at hand when wanted, the same object—namely, turning the article without holes, or indentations of any description—can be attained by fastening a common piece of wood to the spiked or screw chuck, and in this wood turning out a recess or cavity of such a size that the ornamental wood will fit it tightly. This is a method very often resorted to by turners, and is a very ready one. This plan is also often brought into requisition when turning articles of such a shape as will not admit of their being held by any of the chucks in the operator's possession. A recess the shape of and rather smaller than the article is turned in the wood on the face-plate, and into this the ornamental object is forced, and when practicable the centre is brought up so as to keep it in place. When this cannot be done, and when the article is so smooth that it runs round in the cavity when the tool is applied, a little soft chalk should be rubbed both about the chuck or recess and that portion of the object that fits into it.

How to use Turner's cement.

Another means of turning without holes.

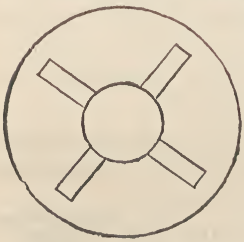


FIG. 272. FACE-PLATE.

564. Although the turner uses other chucks for special work, those which have been already described will alone be mentioned for two reasons :—*Firstly, because the amateur artisan will find that, with proper management, those already described will as yet answer his every purpose and, indeed, wish. Secondly, the other more complicated chucks are used chiefly in iron and brass turning, which chucks, nevertheless, also answer well for ornamental wood turning.*

Chucks described sufficient for ordinary purposes.

565. It is only necessary to add that although the different chucks are generally made of iron or brass, which, indeed, are the best materials, the amateur mechanic, if he would like to make them himself

can make them of hard wood. For some reasons wooden chucks are better than iron ones, but they are not so durable. If in turning the tool comes in contact with a metal chuck, the cutting instrument gets the worst of it; but if the same thing occurs with a wooden chuck, the chuck itself will be much damaged.

Home-made chucks.

566. The tools used by the ornamental turner are very numerous; but different sizes of the gouge, flat chisel, diamond point, and cranked tool will do for a great variety of work. In fact, the amateur artisan is strongly advised to commence with these only, and not to get others until he finds that he really requires them.

Tools used by ornamental turner.

567. The gouge is shown at figs. 273 and 274, the former showing its appearance at the back and the latter at the side. It is used for "roughing down," or taking off the bulk of the superfluous wood, and for turning out hollows and curves that cannot be conveniently done with a flat or other chisel; and when the user of this tool has had a little experience, it may be used for squaring down the end of the article. For the first two purposes it is laid on the rest with the round side downwards, and it must be held with the cutting part rather above the centre of the work, as shown in fig. 275, in which A is the article to be turned, shown in section, and B the gouge. For the third purpose it must be held on its side and pointed directly to the centre.

The gouge.

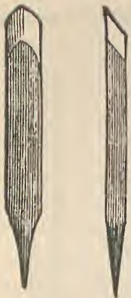


FIG. 273. FRONT VIEW. FIG. 274. SIDE VIEW. GOUGE.

FIG. 275. MANNER OF USING THE GOUGE.

568. The flat chisel, shown in figs. 276 and 277, is used for smoothing the work, or taking off the remaining wood that was left by the gouge. Inexperienced or thoughtless turners generally hold this tool with the cutting edge *parallel* to the surface of the wood. In this position it acts as a scrape, and causes a roughness on the work which is a sure sign of a slovenly workman. The proper position for holding this tool is with its cutting edge obliquely to the surface, as shown in fig. 278, where A is the rest, B the flat chisel, and C the surface of the article that is being turned. When held in the manner indicated in the illustration a much smoother surface is obtainable, and the tool does not require sharpening so often as it does when held wrongly.

The flat chisel.

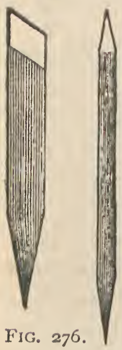


FIG. 276. FRONT VIEW. FIG. 277. SIDE VIEW. FLAT CHISEL.

569. The diamond point, shown in front view in fig. 279, and in side view in fig. 280, is used for roughing very small and delicate work that

The diamond point.

will not bear the gouge being applied to it, or heavy cuts being taken off; for finishing sharp angular corners; and for internal work, such as large holes or cavities, into which the other tools cannot be got conveniently. The point only is used for the first purpose, and the point and sides for the second and third. The point should seldom or never be held above the centre. Cranked or internal tools, one of which is shown

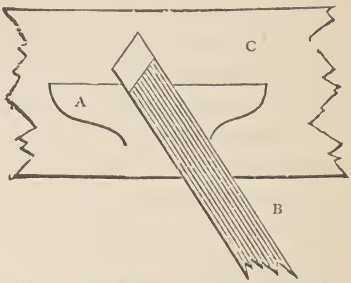


FIG. 278. MANNER OF USING THE FLAT CHISEL.

Cranked tool.

in fig. 281, are used for turning recesses in a piece of wood, or for turning holes when any portion of the interior is either not straight or larger than the orifice. The cutting point is held level with the centre.

570. The tool-rest must be altered to suit the work. It will generally be required rather above the centre, but the height of the operator must

Management of tool-rest.

govern this to a certain extent. The nearer the rest is to the work the greater is the command that the amateur artisan has over his tools. To get it sufficiently close it will sometimes be necessary to place the rest at the same angle as the work; but in whatever position the rest is placed, care should be taken that it is firmly fixed. To the experienced turner it is a matter of very little consequence whether the rest is an inch or two from the work or quite close to it: but until the amateur *knows* his tools, and begins to work with some degree of confidence or certainty, he should not, if he can avoid it, have his rest more than an inch from that portion of the work on which he is operating. If kept at a greater distance than that he will be very liable, or indeed he will be almost certain, to catch in his tool which, flying up, will strike him in the eye or mouth.



FIG. 279. FRONT VIEW. FIG. 280. SIDE VIEW. DIAMOND POINT. FIG. 281. CRANKED TOOL.

571. When turning anything down to a certain size, we cannot do it

near enough by the eye, but must use instruments called callipers ; and although these have already been mentioned in a previous chapter, it will be useful to refer to them again here, as it is in turning that they are found especially useful. The callipers must be set to the proper size, that is, to the diameter to which the work is to be turned down, and occasionally applied to the work until it has been made small enough.

Turning down to certain size.

572. The ordinary forms of callipers are represented in figs. 282, 283,

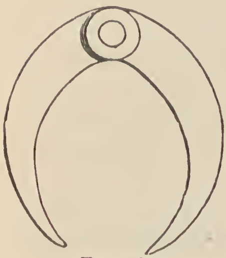


Fig. 282.

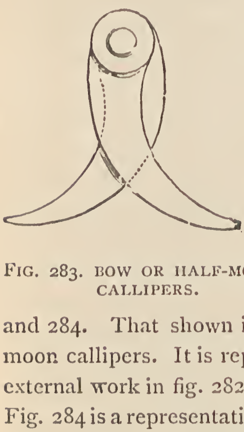


Fig. 283. BOW OR HALF-MOON CALLIPERS.

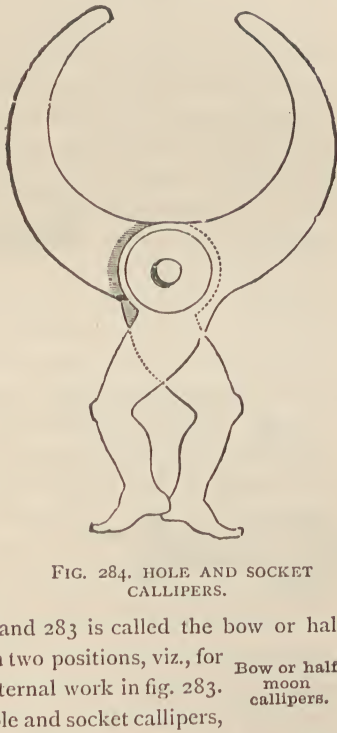


Fig. 284. HOLE AND SOCKET CALLIPERS.

and 284. That shown in figs. 282 and 283 is called the bow or half-moon callipers. It is represented in two positions, viz., for external work in fig. 282, and for internal work in fig. 283. Fig. 284 is a representation of the hole and socket callipers, which will be found very useful in turning boxes and covers. When one end is set to the size of the hole the size at the other end will be that of the cover of the box, or the socket that fits into the hole.

Bow or half-moon callipers.

Hole and socket callipers.

573. No amateur should be without an oil-stone. His tools, not only those used for turning, but his joiner's tools, will continually get dull and blunt ; he *must*, therefore, have some means of sharpening them. The subject, however, of oil-stones has

Oil-stone indispensable.

been fully discussed, and is only alluded to here as a reminder to the amateur, who is generally far more careless than he ought to be with regard to sharpening tools.

574. After the required size and shape has been given to the article, unless it has been very well done and with exceedingly sharp tools, a sheet of glass paper should be held against the work as it rapidly revolves. This will smooth it and take out any little asperity or tool mark that may have been left there. If the article is a pattern for a casting in metal, so far as the lathe is concerned, it is finished; if it is a handle, a little oil is often poured upon some fine shavings, and these are applied to the surface; this will greatly improve its appearance. Articles which it is intended to French polish can be done much better in the lathe than by hand.

Finishing with glass paper, etc.

575. Before the amateur turner tries his hand on work that must be done tolerably well, he should put some rough wood in the lathe and commence operations upon that. He should next turn his attention to those things which, although they are better done well, are not spoiled if done in an indifferent manner. Now he will require several handles, some of the shape of fig. 285—these are used mostly to hold turning tools—and some of the shape shown in fig. 286. These will be wanted to hold tools for several kinds of work. The first sort should be about 10 inches or 12 inches long and about 1 inch and a quarter in diameter at the largest part; the ferrule F should be about three-quarters of an inch, internal diameter. The other sort should be of several sizes, from 3 inches to 4 inches in length, with a ferrule ranging from a quarter to three-quarters of an inch in diameter. The rough wood is put into the lathe, and the end nearest the centre turned down to such a size that the iron or brass ferrule can be hammered on tightly. The remaining portion can then be finished.

First efforts in turning.

FIG. 285. HANDLE FOR CHISEL, ETC.

Tool handles.

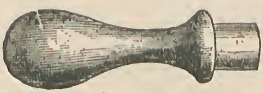


FIG. 286. HANDLE FOR BRADAWL, ETC.

576. It may be useful to give a few other examples for turning of a tolerably simple character on which the amateur turner may try his hand. If he can manage to turn out any one of these in a tolerably workman-like manner, he may rest assured that he is sufficiently advanced in the art of turning to carry out anything he may be called on to do in the way of ornamental

Higher branches of turning.

carpentry and joinery for the house and garden. It is the chief object of this book to help the amateur to do really useful work; the higher branches of turning will require far more practice than most amateurs are inclined to give, and those who can do so will find detailed instructions for every kind of turned work in Bergeron's work, or in any of the less pretentious treatises that have been written on this subject.

FIG. 287. SPINNING TOP IN POSITION FOR TURNING.

577. In fig. 287 a spinning-top is represented in the position in which it should be turned. "Boxers," as they are called from the material of which they are made, are considered to be the best, but any other sort of wood besides box can be used. A hole for the spill should first be bored up the centre, and this hole should act as the centre hole for the steel point of the lathe. **Spinning-top.**

578. Fig. 288 represents the position in which the pattern for a steam cylinder should be placed to be turned. A rough piece of wood should be selected rather larger than the required shape. This piece must be sawn in half, the cut surfaces planed up, and a coat of glue given to each; a piece of thin paper should then be put between the pieces, which should be brought together and held tightly in this position until the glue is dry. The piece can now be put into the lathe and turned. Care must be taken that the centre line passes through the joint. After being turned it can be easily knocked into two parts, and the plain portions put on in place. **Steam cylinder.**

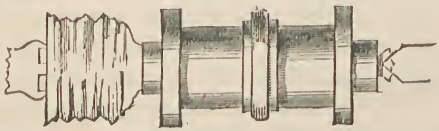


FIG. 288 STEAM CYLINDER IN POSITION FOR TURNING.

579. In fig. 289 the leg of a table is shown in position for turning. It should be made of some fancy wood, such as walnut or mahogany. This cannot be done too well. The shape need not be exactly like that shown in the engraving, but the turner can vary the form to suit his taste or fancy. In fig. 290 is represented a piece of wood for a table-top, stuck to the face plate with Turner's **Leg of table.**

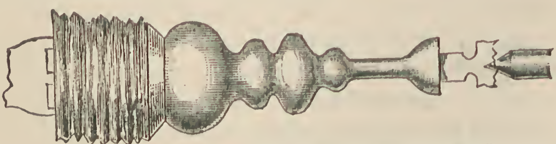


FIG. 289. TABLE LEG IN POSITION FOR TURNING.

cement. The tool-rest is also shown in the proper position at A. When one part of the top is turned it may be knocked off the plate. A piece of wood should now be fastened to the plate, and in this wood a re-

Top of table.

cess turned out of such a size that the turned portion of the table-top will lightly fit it; the remaining portion can then be turned to shape. If the table is turned in this manner there will be no holes or marks to disfigure it, as will necessarily be the case if it be done in either of the chucks.

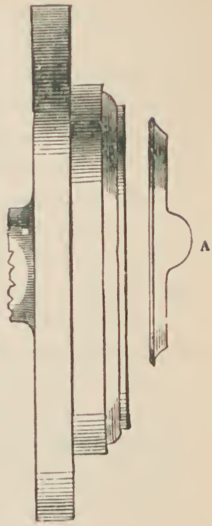


FIG. 290. TABLE-TOP IN POSITION FOR TURNING.

580. We must now consider briefly the prices of lathes and tools used in turning, and this may be best done by bringing under the

Prices of lathes, etc.

reader's notice two or three of the best kinds of small lathe suited for the amateur's purpose. The price of a lathe depends entirely upon its size and fittings, and if the amateur desires to become the possessor of a large and powerful lathe, big enough to turn a post for a four-post bedstead—or, in other words, a lathe with a 6ft. bed—the best and cheapest way of going to work is to buy the different parts and make the lathe, or have it made by a

Second-hand lathes.

joiner. Occasionally an excellent lathe may be picked up second-hand, or two or three old lathes may be bought for next to nothing, from the component parts of which a new and serviceable lathe may easily be constructed. The various parts and fittings of a lathe are always to be bought separately, and the description and engravings of an ordinary foot lathe already given are sufficient to show their respective uses, and how they are to be put together.

581. A good working lathe, with strong wooden standards and wooden 3ft. bed, or even a 4ft. bed, which is large enough for any

Price of good working lathe.

purpose as far as the amateur is concerned, may be made for about £5, supposing that new poppets, cone mandril, grooved wheel, cranked axle, treadle, etc., are bought expressly for it; but by going to work in the manner above described a lathe may be built for half this sum, or even less.

582. Turning to lathes supplied by the manufacturers, these vary in price according to size of centre and bed, and additional fittings in the shape of chucks, slide-rests, etc., from about £7 10s. to £50. The

following are selected from the list issued by JOSEPH BUCK, 56, *Holborn Viaduct, and* 164, *Waterloo Road, London*—a maker whose lathes and tools, be they what they may, are always good and to be depended upon. The lathes are classified according to size :

Prices of Buck's lathes.

	£	s.	d.
3½in. Lathe, with 3ft. bed, iron standards, and 2 chucks...	7	15	0
" " " 6 chucks, and slide-rest ...	15	0	0
" 2ft. bed, with legs to fasten to bench, 4 chucks, but without standards, driving-wheel, or treadle	5	10	0
4 in. best lathe, with 3ft. bed, iron standards, 5 chucks, pulley divided, index point, etc.	15	0	0
4½in. lathe, with 3ft. bed, iron standards, and 2 chucks	10	0	0
" best lathe, with 3½ft. bed, 5 chucks, and divided pulley...	17	10	0
" back-geared lathe, with 3ft. bed, 3 chucks, and compound slide-rest...	17	10	0
5 in. lathe, with 3½ft. bed, iron standards, and 2 chucks	12	0	0
" best lathe, with 4ft. bed, and 5 chucks...	19	5	0
" back-geared lathe, with 4ft. bed, 3 chucks, and compound slide-rest	20	0	0
" self-acting and screw-cutting, with 6ft. bed, compound slide-rest, and change wheels for foot or driving power	34	10	0
6 in. back-geared lathe, with 5ft. bed, 3 chucks, and compound slide-rest	25	0	0
" self-acting and screw-cutting, with 6ft. bed, compound slide-rest, and change wheels for foot or driving power	48	0	0

Slide-rests of an ordinary description cost from £4 to £6 each. A circular-saw table to fit the T rest of a lathe may be purchased from 12s. to 30s.; and it may be mentioned here while speaking of circular saws, that a circular saw bench to work with treadle, complete with a 7in. saw, may be bought for £7 15s.

583. Lathes consisting of iron frame with bed planed true, wood tool board, iron cone mandril, cylinder poppet head, rest and two tees, turned grooved wheel, crank and treadle complete, with 3 chucks, are supplied at the following rates by MR. MELHUISH, of 85 and 87, *Fetter Lane, Holborn, E.C.*

Melhuish's lathes.

		£	s.	d.
3½in. centre, and	3ft. bed	10	10	0
4½in. "	3ft. "	12	0	0
5in. "	4ft. "	14	10	0
6in. "	5ft. "	17	0	0
6in. double-gear lathe for metal turning		25	0	0
6in. " " with slide-rest and face-plate		30	0	0

584. Turning tools may be bought at from 8s. per dozen, or 8d. each upwards. A useful set of 6 chisels, handled, for soft woods, may be had for 8s., and the same number of gouges for 9s. Tools for hard wood, including chisel end, round end, parting tools, side tools, point tools, bead tools, quarter round, bevel end, square, etc., may be had assorted at 15s. per dozen. Turning squares with steel sliding blades range from 5s. to 9s.; callipers, from 1s. to 7s. 6d.; arm-rest, handled, for 2s. 6d.; lathe carriers from

Turning tools.

2s. 3d.; and slide-rest tool holders from 10s. to 21s. each. The number of tools that an amateur really requires on commencing has been already mentioned.

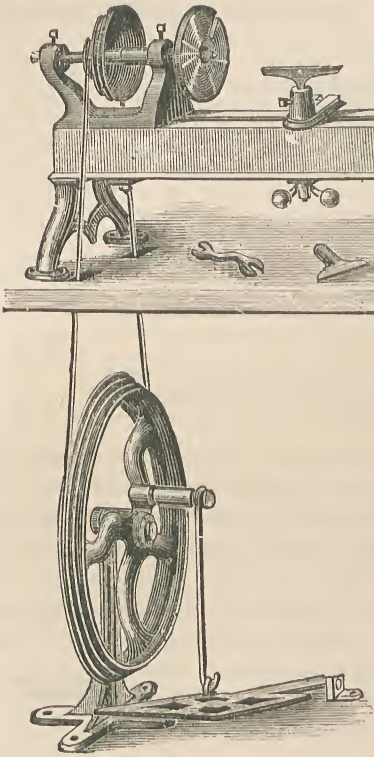


FIG. 291. IMPROVED EUREKA LATHE.

Special lathes for amateurs.

585. Let us now turn to a class of lathes more especially suited for amateurs, with respect to capability, size, and price. Of these we shall describe and give representations of three, namely, the Improved Eureka Lathe, the American Hollow Spindle Lathe, and the Acme Lathe. These, which are all modifications in one form or another of the foot lathe already described, are all sold by Messrs. Churchill and Co.

586. The Improved Eureka Lathe is a complete and perfect lathe capable of turning a piece of wood 14in. long and 6in. in diameter. The bed is of iron, with planed ways. The spindles and centres are made of cast steel, and the spindle is arranged with

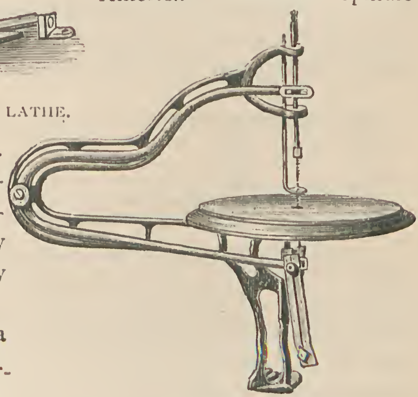


FIG. 292. EUREKA FRET-SAW ATTACHMENT.

patent bearings, so that all wear may be taken up and the spindle kept true. The lathe may be run at a high rate of speed without showing perceptible wear. The parts are interchangeable, and any single part can be replaced in case of breakage. The lathe is suitable for amateurs or any one requiring a small convenient lathe. The lathe in all its parts, with the driving-wheel, is represented in fig. 291, and the fret-saw attachment in fig. 292. This saw attachment can be connected in a moment to the face-plate of the lathe, and will do all fret-sawing of an ordinary kind. It may also be attached to any lathe. The saw-table is 8in. in diameter, and will swing 11in. under the arm.

Improved Eureka Lathe.

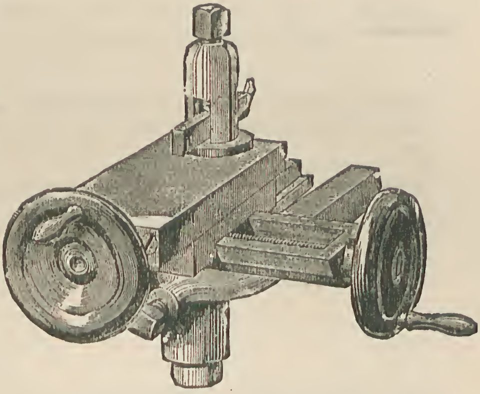


FIG. 293. EUREKA SLIDE-REST.

587. Other attachments are supplied with the Eureka lathe, which greatly add to its general utility, and these are the slide-rests, circular-saw attachment, and amateur chuck. The slide-rest shown in fig. 293 has a longitudinal motion of 3½in., and a transverse motion of 1¾in. It can be used for turning straight or taper work, boring straight or taper holes, or, in short, for any purpose for which a slide-rest is intended. It can be raised or lowered to suit any lathe from 2in. to 3in. centres. Each slide-rest is furnished with four tools. The circular-saw attachment represented in fig. 294 consists of an iron table, measuring 12in. in length and 9½in. in width. It has a steel spindle which runs on the lathe centres. An iron brace is connected to the frame, having one end hinged to the table and the other moved through a slot, and held at any required angle by the tightening of a thumbscrew, thus enabling the operator to do rabbeting, and all kinds of sawing necessary in making picture frames, puzzles, etc.

Attachments for Eureka lathe.

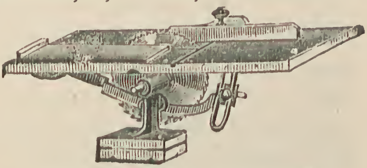


FIG. 294. EUREKA CIRCULAR-SAW ATTACHMENT.

Amateur chuck.

588. The amateur chuck, of which the 2in. size is represented in fig. 295, is especially designed for foot lathes, and for all purposes where a chuck is used. It is made to attach to the lathe by a taper-plug or face-plate. It can be used in a drill-chuck. The 2in. size will hold pieces 2½in. in diameter with No. 1 jaws, and with No. 2 jaws will hold drills from $\frac{1}{16}$in. to $\frac{5}{8}$in. Screws to fasten the face-plate are sent with each chuck.

Prices of Eureka lathe.

589. The prices of the Eureka lathe in various sizes and its numerous attachments are as follow :—

	£	s.	d.
Lathe with 24in. bed without foot-power, weight 24lbs.	2	0	0
,, with 24in. bed, and 14in. foot-power, weight 50lbs....	3	0	0
,, ,, ,, 19in. ,, ,, weight 62lbs...	3	10	0
With 36in. bed, extra	0	8	0
Slide-rest with four tools, weight 4lbs.	1	10	0
Extra tools, each	0	0	10
Circular-saw attachment, with 5in. saw and spindle, weight 9lbs.	1	5	0
Extra saws, each	0	4	6
Fret-saw attachment, weight 7lbs.	0	6	0
2in. amateur chuck, with 1 set of jaws and face-plate fitted	1	10	0
,, ,, ,, ,, 2 sets ,, ,, ,, ...	1	16	0
4in. ,, ,, ,, 1 set ,, ,, ,, ...	1	14	0
,, ,, ,, ,, 2 sets ,, ,, ,, ...	2	2	0

590. This lathe will commend itself to the amateur from the fact that any part that is accidentally injured can be easily repaired, and that the different attachments can be bought one by one as they may be required, or dispensed with altogether. The form of the lathe, which is specially recommended to the notice of the amateur, is that with a 36in. bed and 19in. foot-power, which can be purchased for £3 18s. It is next to useless to buy a lathe without foot-power, as this must be furnished in one way or another; but if the amateur has a driving-wheel that he can connect with the lathe, the Eureka with a 36in. bed will only cost him £2 8s.

Why well adapted for amateur.

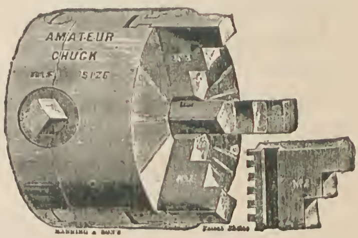


FIG. 295. AMATEUR CHUCK.

591. The American Hollow Spindle Lathe, with back-geared head, is a new and useful lathe for amateurs. Its form and construction is shown in fig. 296, in which the back-geared head is clearly defined. This head enables the operator to work at a very slow speed, at the same time having greater power. Much heavier work, especially on

metals, may thus be executed on this lathe, which is of a superior finish throughout. The spindle of steel runs in conical bearings of iron, with arrangements for taking up all wear. There is a hole, ¼ in. in diameter, running through the spindle, which allows small rods to be passed through and held in a

American Hollow Spindle Lathe.

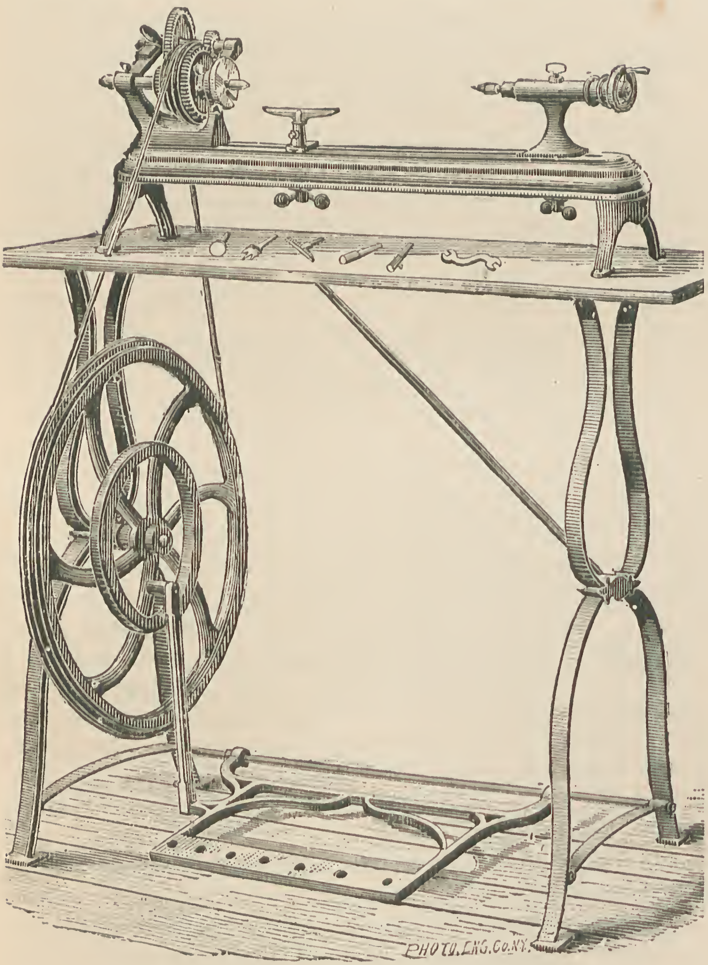


FIG. 296. AMERICAN HOLLOW SPINDLE LATHE.

chuck, a valuable addition when small screws or other small articles are to be made from rods. The tail-block has a sliding spindle, worked by the screw and wheel. The head has a pulley with three speeds, which,

combined with the back-gear, gives great variety. It has 3in. centres, and the bed is 30in. long, so that work 18in. in length may be turned in this lathe, which can be used with equal facility for turning, drilling, polishing, sawing, etc.

Extra pieces supplied with lathe.

592. The following pieces are supplied with the lathe: two T rests, one face-plate, two plain centres, one spur-centre for wood, one plain drill-chuck, one drill-pad, and one centre left blank to turn down as a fitting for a universal chuck. The Eureka slide-rest, circular-saw attachment, and fret-saw are fitted for this lathe, for which the drill-chucks are supplied properly fitted. It may be said that in every respect this lathe is suitable for all purposes for which such an instrument is usually required by amateurs. The table is neat and strong, and the fly-wheel is 19in. in diameter and weighs 30lbs. The following are the prices at which this useful lathe and its fittings are supplied:

	£	s.	d.
Lathe, as in illustration, with back-gears and table, complete, weight 108lbs.	7	0	0
,, without back-gears, but with table, weight 104lbs.	5	8	0
,, with back-gears, but without table, weight 31lbs....	4	12	0
,, without back-gear or table, weight 27lbs...	3	0	0
Foot-power, 19in. wheel, standard, and treadle, weight 39lbs...	1	10	0
,, 14in. ,, ,, ,, weight 25lbs...	1	0	0

Prices of lathe and extras.

593. As this is certainly the best, cheapest, and most complete lathe that the amateur can obtain, and one which can be rendered adaptable for all purposes by fittings which are constructed so as to be used with it, and which have been already named, it may be useful to complete our notice by appending the prices at which these fittings are supplied. It must be remembered that they are extras, and are not included in the ordinary pieces that accompany the lathe at the prices above named. A slide-rest with a set of four tools may be bought for £1 10s.; a circular-saw attachment with spindle and 5in. saw for £1 5s.; a fret-saw attachment for 16s.; a 2in. amateur chuck with one set of jaws and face-plate fitted £1 10s., or with two sets of jaws, £1 16s.; a 4in. amateur chuck, with one set of jaws, etc., £1 14s., or with two sets, £2 2s.

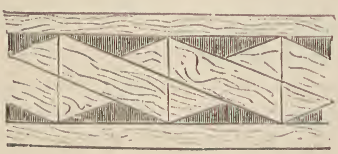
Ordinary T rest.

594. There are many other lathes, all agreeing in general principle, but differing in some points in construction, which space will not allow us to notice here. All that is now requisite is a few remarks on the nature of the slide-rest, which has been mentioned two or three times in the last few pages. The ordinary T rest, described with the foot lathe, fits into the holder by means of a round spill, and can be fixed in a position parallel to the bed of the lathe, or t any angle to it that may be requisite. The tool, however,

remains entirely under the control of the operator, that is to say, he must give it such motion when on the rest as may be necessary to make the cuts that he requires. He must push it forwards or pull it backwards, or move it from one end of the rest to the other as may be necessary.

595. With the slide-rest, however, it is very different. The principle of this useful addition to the lathe is nothing more nor less than that of two slides working at right angles to one another, the upper one carrying the tool which is clamped to it. This will be seen on looking closely at the engraving of the Eureka slide-rest (fig. 293). The entire attachment is fixed to the bed of the machine, and the tool in use is shown in position at the top secured by the clamp. By moving the wheel to the right by the handle which is attached to its circumference, the screw to whose head the wheel is attached will be turned, causing the upper part to travel along the lower part in a direction parallel to the screw, or, in other words, up and down the length of the screw, according to the direction in which the handle is turned. The wheel to the left is attached to the head of another screw, which works at right angles to the first screw, and by which the tool is withdrawn from or propelled towards the work. The main or lower slide is contrived to work on a central pivot, thus imparting a third movement to the slide. Thus, by the combination of these three movements, the operator can, by merely turning the wheels or altering the position of the rest with respect to the lathe bed, give any direction whatever to the cutting edge of the tool, which is of the greatest importance, and indeed indispensable in turning tapered work, and cutting screws and spirals. The spiral columns sometimes seen in furniture are turned by the aid of the slide-rest.

Principle of slide-rest.



CHAPTER III.

VENEERING AND CURVED WORK.

Veneering : what it is—Laying Veneer not difficult—Laying Veneer on Flat Surface—Veneering Hammer—Preparation of Ground—Preparation of Veneer—Removal of Creases—Relaying Veneer—Cutting Veneers—Proceedings after work is dry—Veneering with Caul—The Caul : its construction—Locking Caul by Handscrews—Warping of Woods—How to remedy Warping—Prevention of Warping—How to make a Drawing Board—Clamping Ends of Board—Warping of Rings of Wood—Curved work in Wood—Steaming and Bending Wood—Making Curved Rail—Adjustable Circular Plane—Rounded Work for Framing—Rounded Corner of Passage, etc.—Curved Work in thin Wood—Description of Process—Strengthening Curved Work thus made—Curved Work thus made not true—Curved Work for Castings, etc.—Acute Curves—Construction of Thick Curved Shapes—Building up Curved Work—Curved Work in Pattern-making—Patterns, pattern-making, etc.—Patterns necessary for Castings—Amateur should make his own Patterns—Flange : meaning of term—Flanged Casting—Method of making Flange in Pattern—Sharp edges to be avoided—Sides to Pattern to Taper slightly—Holes in Castings—Cylinder pierced with Hole—Globe or Sphere with Hole—Patterns better made in Parts—Sudden change in size of parts of Pattern undesirable.

596. WHILST explaining the first method of dove-tailing (see section 457) it was remarked that it was seldom used for outside joints unless the outside was to be afterwards veneered. By veneering is meant the laying a thin sheet of valuable wood upon a common and cheap wood. This is sometimes done to cover and hide joints, but more frequently to give the less valuable wood the appearance of the ornamental wood of which the veneer is made. If done well it will be very durable, and is a cheap way of getting a handsome effect. Of course the larger the article the greater will be the saving : indeed, for very small objects the extra labour will out-balance the saving in material, and therefore such articles are seldom veneered, but made of the solid, valuable wood. Veneers, as it has been already said (see chapter ii.), are generally cut from mahogany, rosewood, bird's eye maple, or walnut, but veneers of almost any other sort of wood can be obtained of the cabinet-maker.

Veneering : what it is.

597. The operation of laying a veneer is not very difficult or trouble-

some. The amateur artisan should be careful to get well-seasoned veneers, and to use the strongest and best glue: upon these his success mainly depend. Bird's eye maple is laid with least trouble and difficulty; rosewood is the most troublesome to lay.

Laying veneer not difficult.

598. When veneers are laid upon flat surfaces the operation is simple enough, and must be effected by the operation to be described presently; but when they are laid upon curved surfaces, an instrument the shape of the curve, and called a "caul," is generally used. The amateur artisan, however, will find that the veneering hammer, of which the side view is shown in fig. 297, and the front view in fig. 298, will enable him to lay his veneer quite as well as, and sometimes better than, can be done with a caul.

Laying veneer on flat surface.

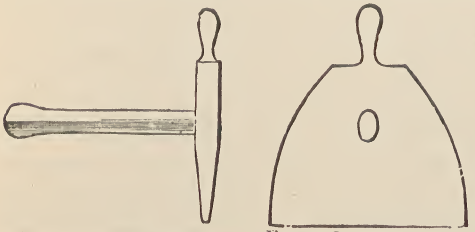


FIG. 297. SIDE VIEW. FIG. 298. FRONT VIEW.
VENEERING HAMMER.

Veneering hammer.

599. Supposing the hammer is to be used, the ground, that is to say, the surface upon which the veneer is to be laid, should be planed or otherwise cut into the required shape, and roughened by rubbing it with a coarse file or rasp, and then warmed, either by holding it to the fire or by passing a hot iron over it. The outside of a veneer should be held over a basin of boiling water, the steam arising from which will slightly damp it; or, if this cannot be done, it may be damped with a cloth dipped in hot water. A thin and even coat of glue must then be given to the inside of the veneer, after which it should, with all possible speed, be laid on its place, and the thin broad edge of the veneering hammer passed over it in all directions, beginning at the centre and working towards the edges, so as to expel the unnecessary glue and air from between the surfaces.

Preparation of ground.

Preparation of veneer.

600. Should it happen that the glue dries before the whole of the air is got rid of, or that any creases are left in the veneer, or indeed anything occur that will render it necessary to remove the veneer after it has been once laid, the amateur artisan must be very careful in raising it, or he will damage the thin sheet of veneer. When once laid it is rather a difficult job to remove it. The proper way is to thoroughly clean off any glue or dirt that may be stick-

Removal of creases.

ing to the outside—some warm water and a cloth will generally do this —dry it by the fire, and whilst hot rub into the surface some linseed oil. Then hold the veneer to the fire until the oil has disappeared, and as soon as this is the case remove it and rub in some more oil. Two or three warmings and oilings will generally moisten and dissolve the glue. The veneer must then be very gently removed, and the old glue entirely cleaned off, after which it is ready to be again laid, and this time, perhaps, with success.

Relaying veneer.

601. The veneer should always be cut a little larger than the surface it is intended to cover, as it slips a little when laying. When laid and dry the projecting edges can be removed with a sharp plane or chisel. The surface of the veneer should be gone over several times with the hammer, working the broad edge over it in every way until the two surfaces have completely adhered in every part. A slight blow here and there with the back or rounded part of the hammer will indicate this by the sound. As soon as the process is complete some weights should be placed on the veneered wood, and the whole allowed to remain in a warm room or near the fire to dry.

Cutting veneers.

Proceedings after work is dry.

602. The process that has just been described is that of veneering with the hammer; it is now necessary to describe the method of veneering with the caul. Although the hammer is all that is required for veneering broad surfaces, such as the front of a drawer or broad curved surfaces of great extent in which the curves are shallow, or even mouldings into which the edge of the hammer is useful for forcing the veneer when the hollows are deep, the caul is desirable and convenient in veneering long narrow lengths of wood, such as are used for picture frames. These may be purchased ready veneered for use at the picture-frame makers in long lengths, but when the amateur is inclined to try his hand at work of this kind, he will find it more convenient to prepare his framing in short lengths.

Veneering with caul.

603. The caul is the exact converse of the surface to be veneered; thus in fig. 299, if A is the wood to be veneered, represented in section B is the shape of the caul that is to be laid upon it. In fact the surface of the caul should fit with the greatest accuracy on the surface to be veneered, any hollow or depression in the latter having a corresponding protuberance in the former, and *vice versâ*. The caul should be made of dry and well-seasoned pine wood.

The caul: its construction.

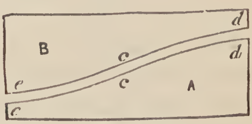


FIG. 299. THE CAUL.

In practice it is found to be advantageous to make the caul of wood thin enough to bend slightly under great pressure, and to cut it in such a way that, while it touches the surface to be veneered in the middle at *c*, it does not fit so closely along the sides or edges *d*, *e*, so that in fact when the surfaces were brought together they would move slightly on and along the line of contact *c*, and each of the edges at *d* or *e* would open according as one or the other in each surface were brought closely together, the opening being sufficient to admit a thin piece of cardboard.

604. When the article has been prepared for veneering and the veneer is ready to be placed on the surface to be veneered, all that is necessary is to glue the surface with thin glue, lay on the veneer, and then the caul, which should be warmed before it is used. Handscrews must now be applied to lock the caul, the veneer, and the wood to which the veneer is glued closely together. Before using the cauls they should be rubbed over with a piece of the best yellow soap, or a strip of paper should be laid between the caul and the veneer. This will prevent the caul and veneer from adhering should any of the glue find its way through a hole in the veneer. By reason of the caul touching only in the middle of the work, it will be found that when the caul and the wood to be veneered are brought forcibly together along the edges by means of handscrews, the pressure will have commenced along the centre line *c* and proceeded from this line outwards on each side as the edges were brought together, forcing before it any superfluous glue, which will ooze out along the edges *d* and *e*, and must be cleaned off when dry.

Locking caul by handscrews.

605. All woods are more or less affected by the weather, damp or heat causing them to warp and get out of shape. This is sometimes the occasion of great trouble and annoyance. After having carefully planed a piece of board true, and having laid it on one side while doing something else, to find, when you have occasion to do something further to it, that the sun's rays have caused it to warp half-an-inch out of truth, is, to say the least of it, rather provoking to any one who does not know how to remedy the evil. In order to repair it, the only thing to be done is to call in the aid of the same agency that caused it to warp, namely, heat.

Warping of woods.

606. Apply heat to one side of a piece of board, and its edges will turn towards the source of heat; if, therefore, the convex side of the board be held to the fire, it will return to its original shape or nearly so. Should it have warped very much, the concave side should be damped.

There would then be two agencies at work: the damp would cause the fibres on one side of the wood to expand, and the heat would cause the side that is turned towards it to contract.

How to remedy warping.

If a piece of wood has become warped by lying exposed to the sun's rays, it will in nine cases out of ten return to its original shape, after the other side has been exposed to the sun in its turn. When it is of importance that a piece of wood should not be affected in this manner, but retain its original shape, we must adopt some means of preventing it from warping. This at first would seem to be easier said than done, but when we come to observe that the wood always warps in the direction of the grain or fibre the difficulty vanishes, for another piece being glued or otherwise fastened to it, so that the grains are in contrary directions, it is obvious that each piece will keep its neighbour in order.

Prevention of warping.

How to make a drawing-board.

607. An example of the simplest way of preventing a piece of wood from warping is shown in the annexed illustrations, which represent in plan (fig. 300) and section (fig. 301) a drawing-board of the cheapest and commonest form. A B G H is a piece of wood, the grain of which runs in the direction of its sides or in the direction of the line A B. If this piece of wood were exposed to heat the sides A B, G H, would rise towards the source of heat, bringing the ends A H, B G, into a curvilinear form. No amount of heat would cause the edges A H and B G to rise and bring the edges A B, H G, into a curvilinear form.

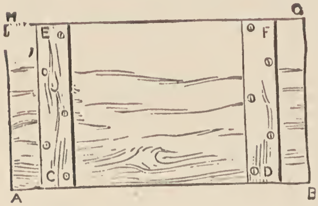


FIG. 300. PLAN OF DRAWING-BOARD.

FIG. 301. SECTION OF DRAWING-BOARD.

To prevent such a board from warping, all that is necessary is to take two slips of wood whose grain runs in the direction of their length, from C to E and from D to F, and to screw them down to one side or the other of the board close to or at a short distance from the edges A H, B G, as shown in the illustration. Now, if a board thus treated be exposed to the sun's rays or to the heat of a fire, it will be found, as said above, that "each piece will keep its neighbour in order." The tendency of the board A B G H to warp will be counteracted by the counter pressure of the slips C E, D F, which will prevent the edges A H, B G, and consequently the whole extent of the board between them, being drawn into a curvilinear form, while the screws along the edges of the slips will keep them in their place, although

they are, in fact, too narrow to warp, for it will be noticed that the wider a board is the more readily it will warp under the action of heat.

608. The method just described, although it is an efficient method of preventing a board, or any number of boards fitted together edge to edge in the direction of the grain, from warping, it is not one which can be adopted in every case, especially when it is desirable to have the surface on each side perfectly level from end to end, as in the case of a drawing-board of the better kind, or in the top of a square deal table. So in such a case as this the plan must be adopted which is shown in figs. 302 and 303, which is technically called "clamping." In this case the board A B C D, whose edges are to be clamped, is tenoned on either side, as shown along the double lines from B to C, and at E and F. The grain of the piece of wood A B C D runs from end to end, or from A to B in the direction of the tenons. Two pieces of wood having the grain in the contrary direction are then grooved from G to H and mortised at K and L; and when ready these pieces are fitted on to the tenoned ends of the board which have been previously glued, the tenons E and F entering into their respective mortises K, L, and the long slip B C into the groove G H. The end A D M N shows one of these clamps in position after being fitted on the tenons, which are shown by the dotted lines. It is manifest that the connection of pieces of wood whose grain is in opposite directions in this manner is as effectual to prevent warping as the method previously described.

Clamping ends of board.

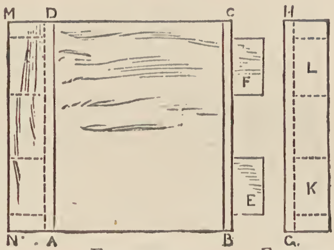


Fig. 302. Board to be clamped.

Fig. 303. Clamp.

609. This warping tendency is not confined to flat pieces of wood, but rings cut out of a solid piece of wood, and exposed either to sun or damp, will very soon lose their shape and get quite elliptical. The method of preventing this will be described further on.

Warping of rings of wood.

610. It is often necessary to make curved work in wood, as may be exemplified in the rounded or elliptic front of a chest of drawers; a rounded corner in projecting wood-work in a passage or lobby where a right-angled projection might be somewhat dangerous or in the way; the rounded door of a corner cupboard often in the exact form of a quadrant or quarter of a circle; and in the flanges of patterns for castings.

Curved work in wood.

611. Wood of any kind may be steamed and bent into shape, and this is the method generally adopted for all curved work in carpentry and joinery, and for bent wood furniture; for when the wood has been steamed, bent into the desired position, and allowed to dry in this form, it will exhibit no tendency to return to its former shape. When a framing is required of which the curvature is but slight, the rails may be sawn out of a solid piece of wood, and the rails thus made and the connecting uprights then fitted together.

Steaming and bending wood.

612. Thus, in fig. 304, if a curved rail were required an inch in thickness and 3in. in width, the extent of curvature from the centre of the face to the centre of the straight line joining its extremities, shown in the figure by the dotted line A B, not being more than 3in., it is evident that such a curved rail may be got out of a piece of wood 3in. square, and of a length a little more than that of the straight line C D, from end to end of the inner arc of the rail. For working the outer and inner surfaces of such a piece of wood as this, it is desirable to have the Adjustable Circular Plane supplied by Messrs. Churchill and Co., shown in fig. 305. Both ends of this plane can be adjusted at the same time by means of the screw-handle. It can be used for either straight, concave, or convex work down to 13in. in diameter. It is furnished with another screw for adjusting the iron, and is neatly made, and strong and simple in every respect. Its price, with a 1¾in. cutter, is 16s. 6d.

Making curved rail.

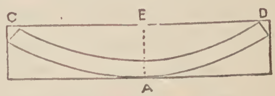


FIG. 304. CURVED RAIL.

Adjustable Circular Plane.

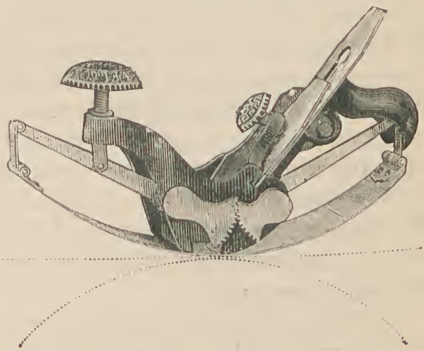


FIG. 305. ADJUSTABLE CIRCULAR PLANE.

613. All rounded work for framing is done very much in the manner described, and the panel is cut in thin wood, exposed to steam—a good jet from a boiling kettle will often prove sufficient when the wood is thin—and then secured in the frame. The moulding must be treated in a way that will be described presently. For work that is permanently fixed, such as the rounded

Rounded work for framing.

corner of a passage, another method is adopted, which is shown in general principle in fig. 306. In this figure the corner is supposed to be in the form of a quarter of a circle, the shape which for obvious reasons such a corner would most frequently take. A plan is marked out, and boards of the height required are taken and fitted together lengthwise by a groove and slip-feather, the edges being bevelled, as shown in the figure at A, B, C, D, and E, so that the section of each board is in the form of a four-sided figure whose two sides are inclined to the longer and exterior face at an angle of 78° 45′, and whose inner and outer faces are parallel to each other. If more than four boards are employed, as shown in the illustration, the angle will be greater than 78° 45′, and if less than four boards are employed, the angle will be less. It is found thus: first find the angle A F B (or any of the four angles at F) which is 22° 30′, being the fourth part of a right angle or 90°. Then, as the three interior angles of every triangle are together equal to two right angles or 180°, the angles F A B, F B A, must be together equal to 180°—22° 30′, or 157° 30′, and as these are equal angles, each will be an angle of 157° 30′ divided by 2 or 78° 45′. If there were three boards, F A B would be equal to 30°, or the third of a right angle; and the angles F A B, F B A, would each be equal to 150° divided by 2 or 75°, and so on for other numbers of boards. When the boards have been glued up and allowed to dry, all that remains to be done is to reduce the angles at G, H, K, L, M, with a plane—a trying-plane is best for the purpose, but a jack-plane will do—until a perfectly circular surface is produced. The inside is left just as it is shown in the illustration.

Rounded corner of passage, etc.

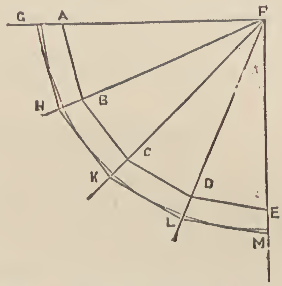


Fig. 306. ROUNDED CORNER.

614. When amateurs have occasion to make any curved work, although they generally take a great deal of trouble about it, they seldom make a neat job of it. Should the piece to be curved be thin, such as, for instance, the flange of a pattern, one of the two following methods will be found to answer.

Curved work in thin wood.

615. Cut out a piece of wood of such a length that will, when curved, occupy the required space. Plane it down to the proper shape and size, and then with a tenon-saw make some saw-cuts all on one side of the wood, and rather more than half-way through it. Suppose, for example, that A in fig. 307 shows the side of a

Description of process.

thin and somewhat narrow piece of board along which saw-cuts *a*, *b*, *c*, etc., have been made from end to end in a vertical direction rather more than half, or say two-thirds, of the thickness of the wood as shown in B, which represents the edges of the board A, at top and bottom after the saw-cuts have been made. It is manifest that the substance of the board, or even its length from end to end, is reduced on the side in which the saw-cuts have been made to the aggregate thickness of the saw-cuts; and if pressure be applied to the ends of the board to bring it into a curved form as shown at C, the edges of the saw-cuts will be brought together, the fibres of the wood in front being slightly strained in order to accommodate the wood to the new form. The smaller the radius of the curve, or, in other words, the greater the degree of curvature given to the wood, the nearer together and the more numerous must the saw-cuts be. Of course by serving the wood in this manner it is very much weakened, thus rendering this method unfit for work when strength is required. It is, however, often used for light, open-work patterns when only a few castings are to be made from them. The amateur will find it useful in making curves in putting down wooden border edging of no great thickness, and in making a bowed front to a box for plants, if the window for which the box be intended be a bow window having a curved or circular front.

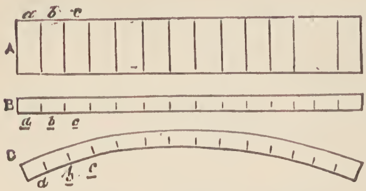


FIG. 307. METHOD OF MAKING CURVED FLANGE.

616. A curve made in this way—provided that the wood is afterwards brought in contact with no moist substance, or substance that must be constantly moistened, as earth in a window box—may be rendered somewhat stronger by laying the piece flat upon the bench with the cut side upwards, then rubbing some strong glue into the cuts, bending it into the required shape, and gluing a piece of canvas over the cut side. When dry it will retain its shape and stand rougher usage than it would before. The canvas will in a great measure prevent it snapping at any one of the saw-cuts, which wood so treated will do at times, especially if the saw-cut has been carried a little too deep into the substance of the wood.

Strengthening curved work thus made.

617. A moment's thought will show the amateur artisan that, however well this curve is made, it will not be a portion of the circumference of a true circle, but will consist of a series of small flats. If the saw-cuts are very close together,

Curved work thus made not true.

the flats will be small, and practically will not make much difference; but if the saw-cuts are a good distance apart, the flats will be large enough to unfit the curve for nice and particular work.

Curved work for castings, etc.

618. A far preferable method than the foregoing, when the curved work is to be made for patterns of castings, is to get a piece of good ash, this wood being better adapted for work of this kind than any other on account of its elasticity. After planing it down to the required size and shape, lay it in a wet place, in such a position that the part intended for the *outside* of the curve only may get wet. When the water has soaked into it, remove it from the damp and hold the inside to the fire. As it gets warm gently and gradually bend it to the curve. By the time the outside is dry it should be bent into the shape, but if it should happen that the outside is dry before the bending process is finished, a wet cloth should be drawn along over the outside, after which heat and gentle force must be again applied. When very acute curves are required, such as those shown at A and B in fig. 308, they should be carved out of a solid and sound piece of wood. Alder is generally used, and answers well. A watch-spring saw for this sort of work would save the amateur artisan a great deal of time and trouble.

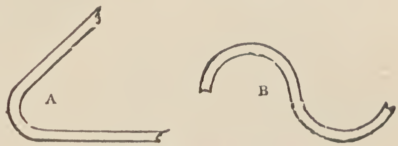


FIG. 308. ACUTE CURVES.

Acute curves.

Construction of thick curved shapes.

619. Thin curved pieces of board, similar to fig. 309, are cut to shape by means of the cross-cut saw, key-hole saw, or any narrow saw that may be worked in accordance with the curves. When curved shapes are required too wide and thick to be bent and too large to be cut from a solid piece, they must be built up as seen at figs. 310 and 311; each brick, if we may so call the pieces, is similar in form to that shown in fig. 312. When done in this way it is not liable to warp.

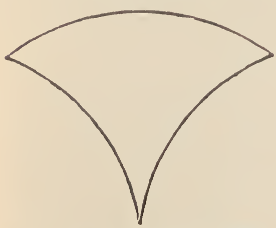


FIG. 309. PIECE OF THIN CURVED BOARD.

Building up curved work.

620. To build up a piece of curved work in this way the circle or curve should first be drawn on a piece of board that has been planed true and even. The first layer of bricks, previously cut out with a saw adapted for this kind of work, and planed true on one side, must be pegged on the mark with wooden pegs or

pins. The top side must then be planed true, and another layer glued and pegged on the top of the last in such a manner that the middle of each of these comes over the joints of the last, or, in other words, each layer must break joint with its predecessor. The method to be adopted in drawing the plan of the curve on the board is shown in fig. 310, and the method of building up the curve from the pieces, and pegging the pieces together, in fig. 311. After the building is finished and the glue dry, if the curve is but a small portion of a circle, or if it is not a true circular curve, it must be lined out with compasses and brought to shape by means of planing. If, however, it is a circular ring, as in fig. 311, it will be a difficult job to finish it off properly in this way, but it can be done with ease in a turning lathe.

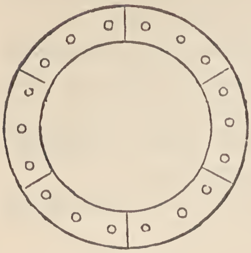


FIG. 310.

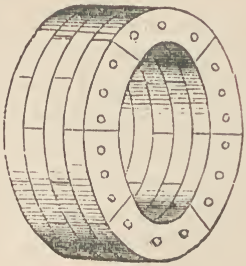


FIG. 311.

CURVES FORMED IN BRICKS.

FIG. 312.
BRICK AND PEG.

621. Curves made both of thick and thin wood are often required for pattern-making, most patterns having some curved work about them ; a pattern with *all* straight edges has a very ugly appearance, therefore, when practicable, curved lines are introduced.

Curved work in pattern-making.

622. The words "patterns," "pattern-making," and "pattern-makers" have been made use of several times in the last few pages. Some readers may not know the meaning of the words in their present application, but the first being explained, the others will explain themselves.

Patterns, pattern-making, etc.

623. When any shape is required in cast metal of any sort, such as iron, brass, gun-metal, lead, etc., it is first necessary to construct a model, or *pattern*, in wood of the same shape as the article required in metal. One pattern will do for a great number of castings, but every different shape, or different size of the same shape, must have a pattern made before a casting can be obtained. Pattern-making, therefore, is rather an important branch of the wood-working art. It is a trade by itself, and, indeed, in large engineering establishments a number of men are always employed in

Patterns necessary for castings.

making patterns in wood to be afterwards used to obtain metal castings.

624. If it is the intention of the amateur to go further than the mere application of the wood-working art to ornamental purposes, and all others for which a knowledge of ordinary carpentry and joinery is sufficient, and to become practically acquainted with the manner of working metals in the construction of models of machinery, etc., then he should be able to make his own patterns. To do so most of the joints and other operations already described will be called into requisition ; in fact, to make most patterns very little more knowledge is required than the reader has already acquired. It will, however, be useful to take a pattern, and, with the amateur, in imagination, go through the process of making it.

Amateur should make his own patterns.

625. Suppose fig. 313 to be the drawing of a pattern or model we

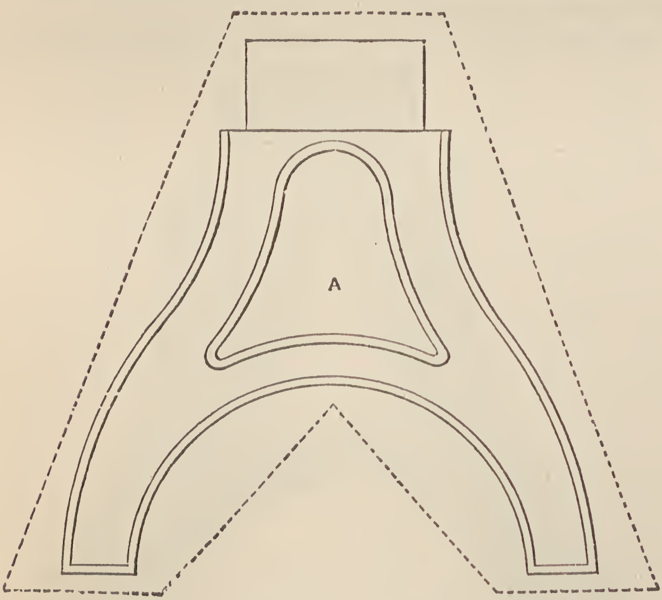


Fig 313. PATTERN FOR A FLANGED CASTING.

wish to make in order to have an iron casting from it, and suppose, also, that it is required to be 6in. high and 3in. wide at the widest part, the frame to be ¼ in. thick, and the flange to be ¾ in. wide. Before going further it may be as well to explain the meaning of the term "flange," and its use. In small models of machinery it is often the case that the weight of the model

Flange: meaning of term.

is hardly sufficient to keep it firm on its legs or supports, and sometimes the maker wishes to polish the whole of the surface of the casting; in either of these cases the pattern, and consequently the casting, must be made solid with flat surfaces, and the same thickness throughout the width; but whenever lightness is required, the frame of the pattern is made about one-third the thickness, and is strengthened laterally by means of thin strips about two or three times as wide as the thickness of the frame. These strips or flanges are nailed or otherwise fastened to the edges of the frame. In the casting the frame and flange are in one piece without joint or seam, and the casting is nearly as strong as, and much lighter than, the same shape would be if cast solid. A flanged casting has a much more mechanical appearance than a solid one, but the pattern is more difficult to make, and for this reason that description of pattern has been chosen for our imaginary construction.

Flanged casting.

626. The flange will be better understood by an inspection of

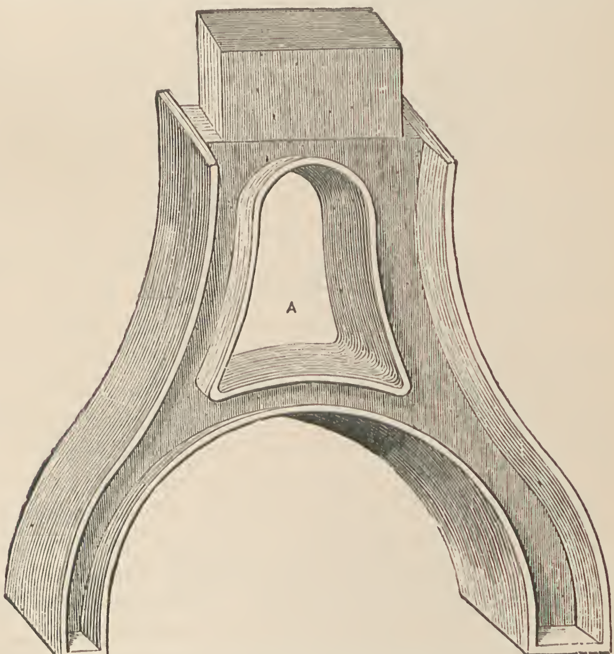


FIG. 314. FLANGED CASTING WHEN MADE.

fig. 314. It will be seen by the illustration that the flange is of the same depth on both sides of the frame. It is generally in that

position, but sometimes the flange is made all on one side of the frame, and the other side left flat. The plan of this style of pattern is shown in fig. 315. But to return to the description. Cut out a piece of deal large enough to contain the frame of the pattern; plane it down till it is ¼in. in thickness. Upon this piece of wood mark the outlines of the pattern.

Method of making flange in pattern.

Saw off the bulk of the wood outside the lines with a tenon-saw: it will then be something the shape of the space enclosed by the dotted lines in fig. 313. With the brace and centre-bit bore some holes inside the space marked A; take a watch-spring cross-cut saw, and cut out the space A to the proper shape, just leaving the lines; with the same saw cut the outside to the shape required, leaving the lines as before. The edges can then be finished with either a sharp penknife or a chisel. The frame is now ready to receive the flanges, which in this pattern are all curved. The small foot-pieces at the bottom are straight, but they can hardly be called flanges. The sweeps of the three outside flanges are not very small, and as for this size pattern they should not be more than ⅛in. thick, they can be made of ash, of a section similar to that shown in fig. 316, and bent to the shape of the sides by one of the methods described before. Each flange can then be bradded in its place. The inside curves are too small to admit of the flanges being made straight, and afterwards bent. They must therefore be cut out of the solid, either in one piece or divided into parts, as shown by the dotted lines in fig. 317, and bradded separately into their places. The pattern must then be well rubbed with glass-paper; all the holes, cracks, and irregularities of any kind must be stopped with putty; and the whole pattern varnished with shell-lac varnish, or well rubbed with black lead.

FIG. 315. PATTERN FOR MAKING FLANGE ON ONE SIDE OF THE FRAME.

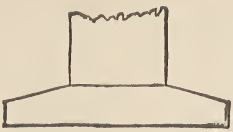


FIG. 316. PATTERN FOR OUTSIDE FLANGE.

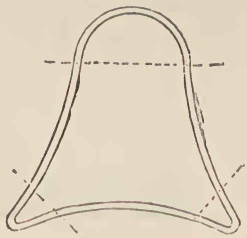


FIG. 317. PATTERN FOR MAKING INSIDE FLANGES.

627. Sharp edges should be avoided as much as possible, because

these edges in the mould are very liable to be knocked off when the molten metal is poured in. Should glue have been used in making any pattern, or grease in any way rubbed about it, care must be taken to clean it off thoroughly before the pattern is used, otherwise in moulding the sand will adhere to the pattern at those places covered with greasy or sticky substance, and a bad casting will necessarily result. The sides of a pattern should not be exactly square, but they should be all slightly tapered off, to allow the pattern to be removed from the sand without spoiling the mould.

Sharp edges to be avoided.

Sides to pattern to taper slightly.

628. Castings are often required with holes through them. When that is the case the pattern is generally made solid, and two pieces of wood called "prints," the size and shape of the required hole, are affixed to it, one piece being affixed to each side of the pattern on the place where it is desired to have a hole. This plan when adopted saves a deal of trouble, but it cannot always be followed, and sometimes it is more trouble to cut out two prints than to make the hole or opening in the pattern, as in the hole or space A in figs. 313 and 314. Should prints have been used, if the amateur makes his own casting, he will know when holes are meant; but if the pattern is sent to a foundry, the word "print" must be written on those pieces intended to be used as such, otherwise, unless the founder knows the purpose of the casting, the prints will be cast solid as projections.

Holes in castings.

FIG. 318.

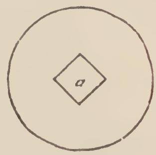


FIG. 319.

PATTERNS FOR CASTING A CYLINDER WITH A SQUARE HOLE IN CENTRE.

629. We will suppose that a cylinder is wanted in metal of some sort, and with a square hole the same size throughout through it, then figs. 318 and 319 would represent the different views of the pattern with prints *a* and *a'* attached to it. Of course if the casting has

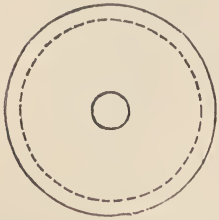


FIG. 320. PATTERN FOR A HOLLOW CASTING.

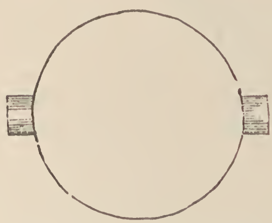


FIG. 321. PATTERN FOR A GLOBE.

to be turned in the lathe it must be made large enough to be the proper size when that operation is finished. When it is wished to have a hollow casting, or a casting with holes in it larger inside than at their orifices, the pattern must have prints affixed to it the size of the orifices. In fig. 320 is represented a globe or sphere, with central and circular holes through it; and hollow, with a thickness of metal, as shown by the inner dotted line. For such a casting the pattern would be like fig. 321; and a "core-box" must be made in two parts, each of which has an opening cut in it of the shape and size of half the internal size of the casting and half the print, as shown at figs. 322 and 323. The use of this core-box, which must be sent to the foundry, is to enable the iron founder to mould the core as shown in fig. 324.

Cylinder pierced with hole.

Globe or sphere with hole.

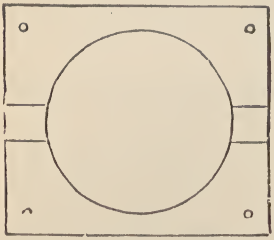


FIG. 322. PLAN OF CORE-BOX.

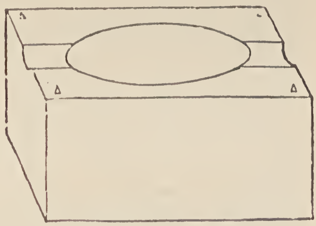


FIG. 323. CORE-BOX.

630. It will be sometimes necessary to make a pattern in several parts, so that one piece can be removed from the mould at a time, and in some cases the pattern cannot be removed from the mould without burning it out. This, however, seldom occurs, but when it does, it will of course necessitate the making of a fresh pattern for every casting.

Patterns better made in parts.

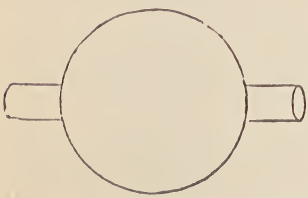


FIG. 324. CORE.

631. A sudden and great change of size of the component parts of the pattern should always be avoided in pattern making. This caution should be particularly attended to. In wheel patterns with heavy rims and bosses, the arms should be proportionately large, or they should be slightly curved, otherwise when the metal is poured into the mould the small parts will get cold and contract much faster than the large, and in contracting will break away from those parts which from their size are still hot, and consequently have not contracted to the same extent.

Sudden change in size of parts of pattern undesirable.

CHAPTER IV.

ORNAMENTAL WORK IN CARPENTRY: FRET-SAWING AND CARVING IN WOOD.

Decorative art in Wood Working—Divisions of the Subject—Carving—Fret-work—Woods used in Fret-sawing—Friction in Fret-sawing—Saw-blade—Sizes of Saw-blade—Colour of well-tempered Blades—To tell Blades that will cut well—Action of Blade depends on Tension—Other Tools required in Fret-sawing—Files: their Shapes and Prices—Archimedean Drill-stock—Cutting Board—Chisels and Gouges—Tools used in Carving—Chisels—Gouges—Skew-chisel and Spoon-bit—Parting Tool and Veining Tool—Frame-saw that Amateur may make—How to make Frame-saw—Balance for Saw-frame—Handle for Frame-saw—Clamp to hold Saw-blade—Small American Fret-saw—Home-made Treadle Machine—How to make Treadle Machine—Patterns and Castings—Fitting Castings together—Arms of Saw-frame—Platform on Table—Hangers—Pulley—Treadle and Driving Wheel—Screw Press for Glued Work—How to make Screw Press—Designs for Fret-sawing—Williams's Ornamental Designs—Tracing Design from Original—Multiplication of Copies—Fixing Design on Wood—Method of Performing simple Fret-work Sawing—Putting the Work together—How to make good Glue—Sand-papering Fret-work—Holder for Sand-paper—Finishing Touches—Polishing Wood—How to make French Polish—How to apply the Polish—Judgment necessary in Finishing Work—The Rogers Fret-saw—Description of Machine—Fret-sawing, a Study of Outlines—Success must be bought with patience—How to Learn to use Tools—Carved Letter Rack—Preliminary proceedings—Application of Carving Tools—The Leaves—Depressions in Leaves—Ribs marked by Veining Tool—Treatment of Stems—Manipulation of Centre—Sand-paper—Fastening down Work—Guidance of Cutting Tool—General Directions for Amateurs—Outline or *Contour*—Direction of Cutting—Carver must have command of Tools—Mezzotint Scraper—Carving Tools and their prices—Star and Chequering Punches, and Riffler—General Mode of Procedure—Holding and Management of the Saw-frame—Saw-gates, or Entrances for Saw—Interior of Work to be cut first—Manipulation of Saw in Cutting—Grain of Wood—Care necessary in Cutting Design—Feeding Material to Saw—Putting parts of article together—Bevelling or Mitring—Determining Angles of Bevels—Method to be Employed—Inlaying—Marquetry and Buhl Work—Mode of Procedure in Cutting Marquetry—Overlaying—Application of this Process—Production of Overlay—Chief Point to be Remembered—Contrasts in Colour—Excellent Decorative Work for House—Carved Work at Trifling Cost—Carving in the Solid—Examples of Carving in Relief—Boss in High Relief—Mode of Procedure in Carving Boss—Carving from Solid on all sides—Examples of Finial—Conclusion of the subject.

632. We must now pass on to that portion of our subject which belongs to decorative art in wood working, by means of which articles that are otherwise plain in appearance may be made highly ornamental, and other things of a strictly ornamental character, but serving some purpose of utility, may be fashioned piece by piece and put together.

Decorative art in wood working.

633. Decorative wood working may be roughly considered as being divided into two parts, namely, Fret-sawing and Carving. Either of these may be carried out independently of the other, and indeed are so, generally speaking; but carving is often combined with fret-sawing to give relief to a surface that would otherwise be plain. It can hardly be said that the reverse takes place, namely, that fret-sawing is used to heighten the effect of carving, although the effect is gained in the elaborate open tracery of the old oak screens still to be seen in many of our old parish churches. Fret-work is of necessity light and open, whether it be finished with carving or not; but carving is for the most part massive and solid, and that this is true may be seen from the fact that fret-work consists chiefly in cutting out an open and elaborate design in thin wood, while carving is cutting and hewing a massive, or at all events thick and substantial, piece of wood into the semblance of some natural object or some conventionalised or purely imaginary form.

Divisions of the subject.

Carving.

Fret-work.

634. Everything necessary with respect to the different kinds of wood used in fret-sawing has been said in Chapter II. of Part I., and the prices of thin woods ready seasoned, sawn, and planed for the fret sawyer's use have also been stated. Other materials, however, may be used besides wood. Gold, silver, copper, iron, and, in fact, any metal which is not as hard as the saw-blade itself, can easily be cut, as also ivory, and bone, and such-like materials.

Woods used in fret-sawing.

635. It is with fret-sawing in wood that we have to deal with especially here, but with regard to fret-sawing in other substances it may be useful to point out this much. If you take a bit of metal and examine it through a magnifying glass, you will find that the fibre is much finer and closer than that of wood. This peculiarity denotes a greater degree of friction when brought under the action of the saw-blade, therefore a different speed must be given to the saw, and the operator must remember to equalise that friction by a lower rate of speed than that required for wood, since all extra velocity increases the friction which it is desirable to overcome.

Friction in fret-sawing.

636. First, it will be as well to consider the saw-blades used in fret-sawing, and then to glance for a moment at the other tools that are necessary. From this we can pass on to the mode of manufacturing a simple saw-frame and treadle machine, and other appliances useful in the prosecution of the art at home, which will be appreciated by those who like to save money by helping them-

Saw-blade.

selves; and, lastly, consider one or two fret-sawing machines which have the merit of simplicity and cheapness, and are not much more costly than a machine which an amateur may make for himself.

Sizes of saw-blades.

637. The ten sizes of saw-blades that are used in fret-sawing are represented in fig. 325. They are numbered from 00 to 8, all the sizes being of the best Swiss and German manufacture, except Nos. 7 and 8, which are the best American hand-made. We are now speaking of saws supplied by Messrs. Churchill and Co., who also supply any of the other tools that are mentioned in this chapter. The prices of these saws, which are all 5 inches long, are, for Nos. 00 to 4, 3d. per dozen; Nos. 5 and 6, 4d. per dozen; and Nos. 7 and 8, 1s. 6d. per dozen. Fret-saws are always variable, and whenever they can be procured of good quality it is always more satisfactory and cheaper in the end to purchase half a gross at once, if they are fully up to the standard. The blades should be sharp and true, fairly tempered, of good *blue* steel, and elastic. If too highly tempered they will snap and fly about in the most unpleasant manner. Some saws in a bunch will be cut better than others, and it is a good plan to assort them. With a little practice by passing the toothed edge over your thumb nail you will quickly learn the difference. The saws belonging to each number may be sorted into three grades—the first, comprising those that are admirably sharp and therefore suitable for soft woods, walnut, mahogany, etc.; the second, those that are less sharp and adapted for ivory, bone, metal, or hard gritty woods, in the cutting of which hardly the best saw will hold a sharp tooth; and the third, those that are available for hacking purposes only.

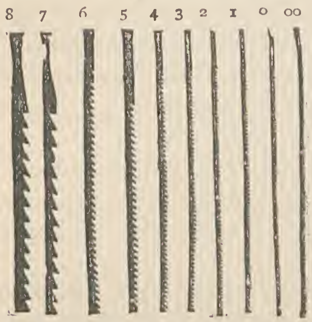


FIG. 325. SAW-BLADES FOR FRET-SAWING.

Colour of well-tempered blades.

To tell blades that will cut well.

Action of blade depends on tension.

638. Upon the proper *tension* of the saw-blade depends its action. For this purpose a number of frames in various styles have been invented. Some of these are exceedingly simple in construction, while others are combined with machinery and operated upon by foot-power. A useful bracket fret-saw is shown in fig. 326, which explains the construction of the frame and the way in which the saw is held in it. The price of these frames are, in birch, 2s. 9d.; in rosewood, 3s. 6d.; in steel, from 5s. to 6s. The wood frames are 12in. long; the steel frames from 10in. to 14in.

639. In addition to a number of saws of various numbers and a frame for holding them, a fine awl is needed, or, what is better, a small drill-stock, called the Archimedean drill-stock, with four or five drills of different sizes, and to these must be added three or four files, round, half-round, square, and triangular, fine cut, and from 4in. to 6in. long, and, if a hand-saw be used, like the saw figured above, a cutting board with an iron clamp to fasten it to a table. If carving is combined with fret-sawing some carving tools will be necessary.

Other tools required in fret-sawing.

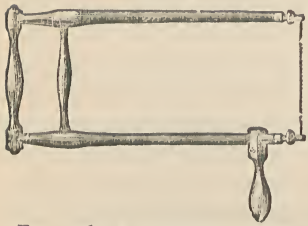


FIG. 326. BRACKET FRET-SAW.

640. The files are made in six shapes, as shown in fig. 327, and are used for clearing out corners and removing any excrescences that may have been left in taking out the perforations with a saw. Their prices are: 3¾in. long, 2s.; 4¾in., 2s. 6d.; and 5½in., 3s. per dozen.

Files: their shapes and prices.

FIG. 327. SHAPES OF FILES USED IN FRET-CUTTING.

641. The Archimedean drill-stock, which is represented in fig. 328, consists of a stock like the broad boss of a brace, into which a drill is inserted and turned by means of a bow and string passing over the knob of wood in the centre of the drill. It costs, with the drills, about 4s. or 5s.

Archimedean drill-stock.

FIG. 328. ARCHIMEDEAN DRILL-STOCK.

642. The cutting board is a piece of walnut or hard wood about 10in. wide and 18in. long, of the shape shown in fig. 329. The board has a clamp attached to its under side, by which it is fastened to a bench or table. The V shaped opening is needed so that the saw can be kept working at B, while the work finds a support at A, A, A, and is saved from breaking. Neat, careful handwork ought to need no filing, except when it is further wrought by carving.

Cutting board.

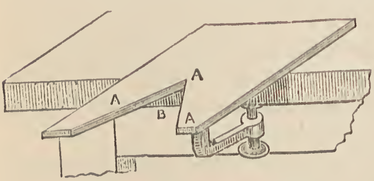


FIG. 329. CUTTING BOARD.

643. There are various kinds of chisels and gouges used in carving,

but all that is absolutely necessary are the three shown in fig. 330, of which A is a chisel, B a gouge, and C a parting-tool. The price of a set of these three tools is 4s. 6d. By carving many fret-work designs after they have been sawed, their beauty can be enhanced, and their value and desirability as household ornaments wonderfully increased. With but very little practice and the use of good tools, any one can learn to carve a simple design and make it very rich and tasteful. Natural objects like leaves, tendrils, flowers, insects, architectural ornaments, etc., may be easily worked in the wood.

Chisels and gouges.

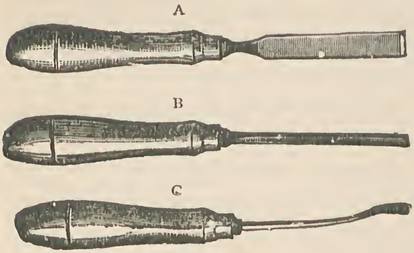


FIG. 330. CARVING TOOLS.

644. As we are now speaking of chisels, etc., it may be as well to complete our notice of them here, instead of recurring to them when we are speaking more especially of wood carving. The tools used in carving are the chisel, the gouge, the skew-chisel, and the parting-tool, but each of these have their variations, whose peculiar shape adapts them for use in confined spaces, where the shanks of the other tools could not be carried back far enough to make a clean cut, the relief of the carving being in the way.

Tools used in carving.

645. The *chisel* is made in various widths from ⅛in. to 1in., has a straight edge, and is used for plain surfaces which are square, removing superfluous wood and grounding. It is the most necessary tool of the set. Its only direct variation is the spoon-bit, or entering-chisel.

Chisels.

646. The *gouge* has a curved edge of various sweeps, according to the depth to be cut. It ranges from almost flat to the exact half circle, in about eight different sweeps. The variations of the gouge are the spoon-bit or entering-gouge, the back bent entering-gouge, the fluting-gouge, and the double bent fluting-gouge. These take their names from peculiarities of construction, or from the particular purpose they are made to serve.

Gouges.

647. The *skew-chisel*, although generally considered as a distinct tool, is a modification of the chisel, the edge being ground back from either corner, the tool being right or left hand. It is useful for working out the inside corners of angles where the edge of the ordinary square chisel would be too wide. Its variation is the skew spoon-bit or entering-chisel.

Skew-chisel and spoon-bit.

648. The *parting-tool* is a sort of gouge or grooving tool, with an angular edge. Its cut is V shaped, and it is absolutely essential for various purposes of cutting angular grooves. The parting-tool is straight or bent, and, like the other carving tools, it has its spoon-bit variation. The *veining-tool* is a parting-tool on a small scale, being narrow, and used to engrave the veins of leaves and similar work.

Parting-tool and veining-tool.

649. By means of the sawing board described in section 642 and a simple frame-saw an amateur who is possessed of patience and perseverance may do much work of a highly ornamental character. He may wish to make a frame for himself, and he may do this without much trouble, if he will read and act upon the following directions. Any one, in fact, who has come to be handy in the use of carpenter's tools can make it at small cost.

Frame-saw that amateur may make.

650. First get two strips of well-seasoned straight-grained maple or beech, about 2ft. long, and about 1in. wide, and 1in. thick. Plane them tapering and perfectly true, so that they shall be each ½in. square at the end A where the saw-blade is to be fastened. At the point where the brace B is joined to the two arms, the full dimensions of the wood (1in.) should be allowed, as the greatest strain will be there. From B to the tail of the frame at C each arm should again taper to ½in. Neatly round off the edges, leaving the under side of each arm flat for a couple of inches at B, so that the brace may be closely fitted. The two arms must next be connected with the brace, for which a piece of maple or beech must be taken, 9in. long and 1in. square, and worked to the shape shown at B in fig. 331, cutting a perfectly true flat tenon 1in. long and ⅜in. thick at each end, and hollowing or chamfering the edges of the brace for the sake of neatness. About 5in. from the tail end of each arm cut a neat and perfectly true mortise for the tenons of the brace, and fit them in tightly with glue and wooden or iron pegs, being careful that the tips of the arms are exactly perpendicular, otherwise the saw will cut crookedly.

How to make frame-saw.

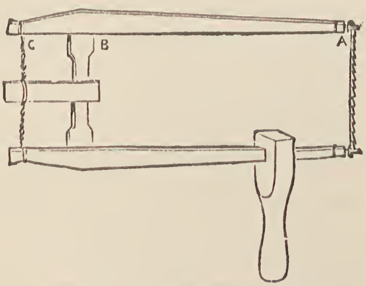


Fig. 331. SIMPLE FRAME-SAW.

651. Now if we fasten a saw-blade to this frame at A the leverage will be too great upon B without a compensating balance at the other end, very much on the principle of a see-saw plank which requires

a boy at each end. The most inexpensive way to achieve this balance for the saw-frame is by means of a piece of twisted cord or catgut, the ends of which should be tied strongly together, making it into a loop just large enough to go over the ends of the frame at C, about ¼in. Prepare a stout flat piece of wood, 6in. long, ¼in. thick, and 1in. wide; place it between the two strands of the cord, and begin to twist it round, enough to make it just tight, and let the stick, which is technically called a *key*, protrude far enough to rest against the brace, and prevent the cord from untwisting. There will only be a slight strain upon the arms. A neat handle should now be shown of the shape represented in the figure. To make this, the amateur must take a piece of hard tough wood, 6in. long and about 1¼in. square, and at one end bore a hole, rather more than ½in. in diameter. Work down the remainder of the wood to make a neat handle, as shown in the drawing. Pass one end of the frame through the hole, and when it fits snugly fasten the handle with a small screw, taking care that it is perpendicular to the arm of the frame to which it is attached, and hangs straight downwards. If it is desired to make a very neat job, and add to the strength of the frame, let the end of the handle through which the hole is bored be made round, and narrow metal bands or ferrules driven on, one on each side of the hole, thus rendering the wood less liable to split.

Balance for saw-frame.

Handle for frame-saw.

652. The next step will be to provide some appliance as a clamp to hold the saws, and if it is not possible to obtain such an article as that which is shown in the illustration, an ingenious smith can no doubt be found who will make a pair for a sum that may be set down as ranging from 1s. to 2s. The shank of this clamp, as in fig. 332, should be about 2in. long, cut for about five-eighths of the length with a screw-thread at one end, and having a saw-slit at the other wide enough to admit any fret-saw, and pierced with a female screw transversely to the saw-cut, into which a small thumb-screw, similar to those used in mathematical instruments but rather larger and stouter, is inserted for the purpose of bringing the parts of the clamp on either side of the saw-slit closer together in a firm grip on the ends of the saw. Having procured a pair of these clamps, drill a straight hole lengthwise in the end of each arm at A exactly in the centre; and having fitted on each arm a brass or iron ferrule, to prevent the wood from splitting, screw in the clamps firmly, greasing the

Clamp to hold saw-blade.

FIG. 332. CLAMP FOR SAW-BLADE.

screw-thread before inserting the clamps into the holes bored to receive them, that they may be screwed in the more easily.

653. In the fret-saw frame that has been described, the depth from the blade to the brace is about 18in., giving room for cutting out a large piece of work. It must be remembered that the size of the work depends altogether upon the sweep of the frame. For this reason the Swiss frames, although useful for small work, are not convenient for fret-sawing, because their sweep is not more than 2in. or 3in., and on this account the toy saw that is sold in the streets and in many shops, at prices varying from 1d. to 6d., is comparatively useless. This little tool, called the American fret-saw, shown in fig. 333, has another disadvantage in the set of the blade, which, instead of being in the same plane as the handle, as it ought to be, is in a plane inclined at a slight angle to that of the handle, which will cause the operator to make a crooked cut when he thinks he is proceeding in a straight line.

Small American fret-saw.

FIG. 333.
AMERICAN FRET-SAW.

654. From the home-made fret-saw let us proceed to the consideration of a home-made treadle machine, the leading principles of which are taken, by permission, from Williams's "Fret-sawing for Pleasure and Profit," and from which indeed the description of the home-made fret-saw, with certain modifications, has been taken. It is satisfactory to an earnest, persevering workman to make his own tools and appliances, and for this reason the methods of making and putting together a fret-saw frame and treadle machine have been inserted.

Home-made treadle machine.

655. As a beginning, two pieces of maple or beech should be procured, as for the hand frame, and worked up for arms. A few castings must next be obtained from the iron-founder's, and for these it will be necessary to make some patterns, not so elaborate as those described in the last chapter, but on the same principle. From a piece of deal cut out a pattern of the shape shown at A in fig. 334. This must be 8in. long, 2in. at the widest part, and ½in. thick. To this fit, at 3in. from one end, at right angles to it and perfectly square, a piece of the shape shown at B, of the same thickness, and fasten A and B together, as shown at C, securely with brads, making the entire pattern as shown in the side view at C. This we will call pattern No. 1. Now make another pattern of the shape shown at D, 5in. long, $\frac{5}{16}$in. thick, ¾in. wide at the ends, and 2in. across the centre. Where the dotted

How to make treadle machine.

Patterns and castings.

line is seen a small V shaped ridge must be fastened on, ¼in. wide and ⅜in. thick, as shown in section at E. This we will call pattern No. 2. From these patterns, which must be square and true, castings must be made, *one* being required of No. 1 and *two* of No. 2. It would be well to mark a rough groove across each end of No. 1 to serve as a guide in filing up the centre. The castings, which will cost from 4d. to 6d. per pound, will be handed to you in a rough state by the iron-founder, and it is necessary to finish them off with a file.

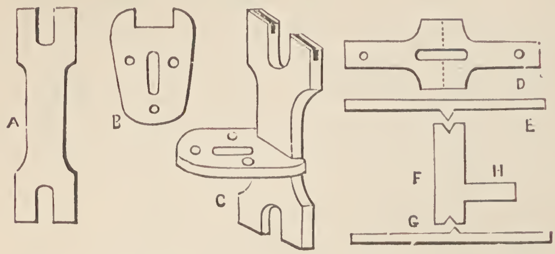


FIG. 334. PATTERNS OF CASTINGS FOR TREADLE MACHINE.

656. With a triangular file trim up the grooves across the ends of No. 1, taking care to keep them perfectly true, often testing the cut with a try-square. Then also file the ridges of No. 2, to make the best possible fit to the grooves of No. 1, as shown at E, F, G; E and G representing pattern No. 2 in section, and F pattern No. 1 also in section. In the step H three holes must be drilled as shown at B, for by it the casting will be held to the table with screws. Similar holes also must be bored at the ends of E and G, as shown in the plan at D, by which they can be fastened to the inside of the arms; and it would be well to have these holes in E and G rather oval than round, that the arms may be more truly adjusted, as the screws that fasten the castings to the arms will hold firmly enough. All the holes should be counter-sunk. Having fitted the castings and fastened them, procure if possible a second-hand sewing-machine table with drive-wheel and treadle; but if this cannot be done, a bench with wheel and treadle can easily be made. A second-hand sewing-machine table may at times be purchased at a low rate from a dealer in second-hand goods, and such a table as this is the best fitted for the purpose, as it can be adapted to the requirement in view without much trouble. The casting No. 1 must first be neatly but firmly screwed by the step H to the back of the table, at about the centre.

Fitting castings together.

Arms of saw-frame. The arms should then be attached in the following manner. Procure two pieces of stout wire 10½in. long and about $\frac{3}{16}$in. thick, and if you cannot do it yourself, get a locksmith to cut a screw-thread in one end of each piece for about 1½in. Have a small

thumb-nut fitted to each screw end, and rivet a small iron washer to the opposite end. Next, cut two holes in each of the arms as large as the thickness of the wire, somewhat conical in shape, and pass the wires through them with the screw ends at the top, fastening them with the thumb-nuts. The structure will then present the appearance shown in fig. 335. The conical holes which are shown in the representation of the arms in this figure are so shaped to give free play to the tension rods.

Platform on table.

657. All that now remains is a small wooden platform of the shape shown at A in fig. 335, which should be screwed to the front of the table, so that the saw-blade when clamped, which can be done by the same means described for the hand-frame, will freely move through the small hole *a* in the exact centre of the platform.

Hangers.

It is also necessary to have a couple of castings of the shape represented at B. Technically such a fixture as this is called a *hanger*. It should be ½in. thick, and measure 6in. in the direction of the dotted line, and about 4in. from *b* to *b*, at which points holes should be drilled for screws to fasten each of these hangers to the under side of the table. At C a hole must be drilled, very true, for these are to serve as bearings for a small shaft about ½in. in diameter. At one end of the shaft is to be fitted a small pulley,

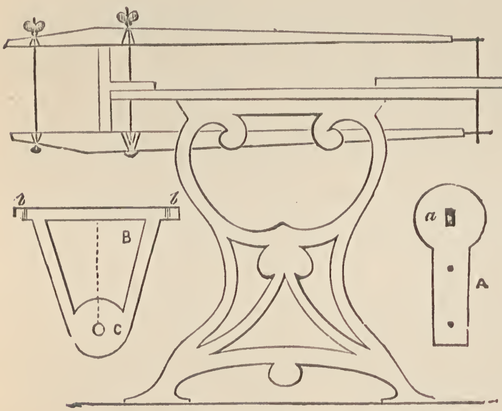


FIG. 335. TABLE FITTED WITH FRAME.

Pulley.

and at the other end an eccentric of about 2in. in diameter, 1in. from the centre of which is fastened a short, flat bit of hard wood by means of a set-screw through one end, while the other end is fastened to the lower arm of the saw-frame by a screw, upon which the short connecting strip will move rather loosely. Attach a round leather belt to the driving-wheel and the small pulley, and the gearing will then be shown as in fig. 336. The machine having been carefully oiled is now ready for work. When fitting the connecting piece to the lower arm, the proper

Treadle and driving-wheel.

length may be determined by moving the saw-frame down, so that the end of the upper arm shall be within ¾in. from the table, and the set screw in the eccentric shall be downwards. Cut the connecting piece just long enough to measure between the lower arm and the set-screw of the eccentric, allowing room so that the lower arm may not strike against the under side of the table.

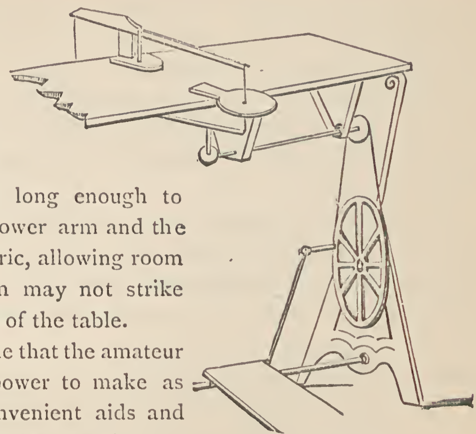


FIG. 336.
GEARING FOR TREADLE MACHINE.

Screw-press for glued work.

658. As it is desirable that the amateur may have it in his power to make as many convenient aids and appliances as possible to help him in his work, we are tempted to give a description of another handy thing which is easily cut out and put together. It is a sort of screw-press, in which glued work can be adjusted and left to dry, while it may be adapted to many other uses which will make this simple apparatus worth far more than it costs.

How to make screw-press.

659. Get four strips of well-seasoned hard wood 1in. wide, from ½in. to ¾in. thick, and 20in. long. In each piece, about 1½in. from the end, cut a notch 1in. long and ½in. deep, into which fit cross-pieces of wood about 4in. or 5in. long, forming two frames, as shown in fig. 337 at A and B. Next procure two strips of hard wood 2ft. long or more, and at least 1in. thick, and exactly as wide as the space between the strips that form the uprights. A joiner's clamp must then be bought which will furnish the screw and nut, which

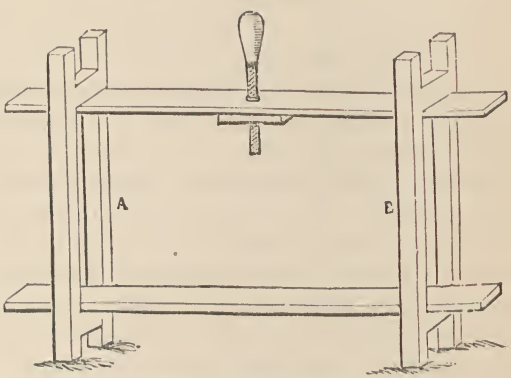


FIG. 337. SCREW-PRESS.

latter will be merely one of the jaws of the clamp. Bore a hole through one of the long strips, exactly in the centre, a trifle larger than the diameter of the screw, and fasten the jaw of the clamp directly under it. Then by slipping the frames over the ends of the long strips the press will stand as shown in fig. 337. A few square wooden blocks and a couple of square pieces of plank will be found convenient to use with it. It will be readily seen that, as the various parts of which this press is composed are movable, it is equally well adapted for large or small articles which are to be glued. A 6in. strip fastened transversely at the bottom of each standard will serve as a foot to keep it upright and steady. Of course the proportions stated can be varied to suit the taste and the requirements of the amateur.

Designs for fret-sawing.

660. The amateur will find no difficulty in obtaining patterns or designs for this work, but it may be as well to point out here that the best and most suitable that he can procure for any and every purpose are Williams's "Ornamental Designs,"[1] a new and valuable series of books, containing mechanical designs of full size for immediate use, which are supplied by Messrs. Churchill and Co.

Williams's Ornamental Designs.

Tracing design from original.

661. The design to be worked in wood should be traced from the original by the following process. Lay the design to be copied flat and smooth upon a table or wide board and cover it with a piece of tissue paper or very thin tracing

[1] The following are the designs included in each book and its price, which varies according to the number of designs that are contained in it :—

Part 1, price 3s., contains designs of picture-frames, small brackets, wall-pockets, book-racks, fancy letters, and figures. All dėsigns in this and other parts are of full size.

Part 2, price 4s., is devoted exclusively to brackets of medium to large size. Over one hundred patterns of brackets are figured in this book.

Part 3, price 4s., is devoted to fancy work, baskets, ladies' workboxes, easels, pen-racks, watch-holders, watch-pockets, match-boxes, paper-cutters, calendar-frames, thermometer-stands, fruit-baskets, table-platters, etc. Nearly one hundred designs.

Part 4, price 2s., contains many patterns of various articles entirely new and of special elegance.

Part 5, price 2s. 6d., contains over one hundred designs of silhouettes and fancy scroll sawing and inlaid work, containing patterns of animals, birds, children, horses, dogs, crosses, scenes of poetry and sentiment, women, soldiers, deer, flowers, mottoes and fancy ornaments, all ready to saw out, and most beautiful for inlaid work.

Part 6, price 1s. 3d., contains twenty-nine patterns of picture-frames, easels, visiting card-case, bracket, doll's carriage, mirror-frame, fancy match-box, etc.

Part 7, price 2s. 6d., contains sixty-two patterns of easels, work-baskets, wall-pockets, motto "Welcome," photograph-frames, wheelbarrows, crosses, match-box, glove-box, savings' bank, standard match-safe. etc. Many of the designs given in this and the other parts can be handsomely carved.

paper, fastening both down to the board with some drawing-pins. Let it be free from wrinkles. Trace the pattern through with a good lead pencil. If desirable a sheet of prepared carbon or impression paper *placed between pieces of tissue paper* may be also laid beneath the design, thereby producing two or more copies.

Multiplication of copies.

662. The tissue tracing paper can be easily fixed upon the wood if a little care and patience are exercised. Let the paste —made of wheat flour—be rather thicker than usual, and brush it over the entire surface of the wood. It is difficult to describe in print how thick the paste should be, but it must be just wet enough to barely moisten the paper. The paste must be applied to the wood only, as the least stroke of the brush upon the thin paper would spoil it. The design being correctly drawn, apply one edge of the tissue paper to the pasted surface, carefully sweeping it on with a gentle motion of the hand, avoiding all wrinkles. When drying, the paper will shrink a little, which will render it quite smooth. This plan of attaching the paper to the wood is both easy and convenient, as the paper can subsequently be removed with great facility by damping it with a moist sponge, and a few rubs with sand-paper entirely obliterates all traces of the paste. On no account should the design be traced directly upon the wood, as the least deviation of a line would disfigure light woods, and on dark woods the impression could hardly be seen.

Fixing design on wood.

663. In simple fret-work sawing the *modus operandi* is easily understood. The piece of wood, prepared with the design that is to be cut out and pasted on its surface, must be pierced in every part that is to be cut away with a hole sufficiently large to admit the saw. It must then be laid on the cutting-board, if a frame-saw be used, and on the platform, if a fret-cutting treadle machine be used, and every opening or interstice carefully cut out with the saw, taking care to keep as closely as possible in the lines of the design, so that as little filing and trimming as possible may be necessary.

Method of performing simple fret-work sawing.

Putting the work together.

664. The various pieces of which the work is composed must now be joined together, and this must be done by the aid of fine tacks and good glue.

665. The easiest and best way to melt glue is to break it into pieces sufficiently small, put them into an earthenware vessel, just cover them with warm water, and set them aside until the glue is thoroughly soaked and forms a stiff jelly. Then pour off all the surplus water, put the jelly into a double glue-pot, and place it on a stove or by the side of the fire to melt. The outside receptacle

How to make good glue.

of the glue-pot must be filled with hot water, for it is very easy to spoil the glue by roasting it. It should only be melted at a temperature not higher than boiling water, and not in any excess of supply at one time, as frequent melting diminishes its strength. When applied to any work it should be quite hot, and of such a consistency that it will just drop from the brush. The pieces to be joined should be warmed, so that the glue may not chill suddenly, and only a thin coat of glue should be applied. If the shape of the work will allow, it must be immediately fastened in the press, which has been described, confined with clamps or tied around with string, and left until the glue is perfectly dry. Instead of using brads wherever the thickness of the wood will allow it, small holes should be drilled not quite through the wood, and wooden pegs of the same colour driven in carefully, which will afford an additional hold.

Sand-papering fret-work.

666. A few words may be necessary on sand-papering fret-work, which should be done immediately after the removal of the paper from the wood, and before the various pieces of which the article is composed are glued together.

Holder for sand-paper.

667. Sand-paper should be very carefully applied with a very light pressure, lest it wear away the surface unequally. A convenient holder for sand-paper can be made with two oblong pieces of hard wood ⅜in. thick, and of any convenient size. In the piece of wood intended for the bottom, fix a 1½in. screw exactly in the middle, sinking the head a little below the surface. At each end of the other piece fasten three small steel pins, with points, filed sharp, and let them protrude about 3-16ths of an inch ; bore a hole in the centre the size of the screw. Place the top piece over the lower one, fitting a small wooden knob to the screw, which will serve to keep the two pieces from coming asunder while in use, and also for a handle to hold them by. A piece of sand-paper can be placed upon the bottom piece just long enough to lap over and be held by the sharp points. The bottom piece should be curved upwards slightly towards each end, so that a sharp edge may not injure any part of the work.

Finishing touches.

668. The work must be finished by polishing, oiling, or varnishing. All work which is to be oiled, polished, or varnished must first be rubbed as smooth as possible with very fine sand-paper, otherwise every little imperfection in the grain of the wood will exhibit itself to critical eyes. When the work is too delicate to bear any strain or pressure, it is best to partly polish the wood before cutting out the design, and give it a finish subsequently. The polished surface must present an even appearance, as nothing

looks so unworkmanlike as blotches and streaks, and when there are any such they must be well rubbed down with an oiled cloth. Only enough oil is needed throughout the operation to cause the rubber to glide along easily without adhering to the surface, which would produce unsightly daubs.

669. Polishing is easy work after a little practice and attentive notice of the effect. French polish is made in the following manner:—

Polishing wood.

RECIPE.—Take 2oz. picked shell lac, 1oz. gum arabic, 1oz. gum copal, and 1½ pints of spirits of wine. Dissolve the gums thoroughly in the spirits, and strain all through a bit of fine muslin. It should be about the consistency of treacle in hot weather; if necessary it can be made thinner by the addition of some more spirits. If the gums are pure and good this will give a light-coloured polish. If a darker colour is desired, substitute 1oz. of gum benzoin for the gum arabic and copal, and use only 1 pint of spirits of wine. If it is required to further colour the polishes it may be done by adding to the mixture a little dragon's blood.

How to make French polish.

670. French polishing is done with a pad of cotton-wool or with a rubber consisting of a few folds of cloth. The cloth is moistened with the polish, and a thin piece of linen rag placed over it, on which are poured a few drops of linseed oil, and the whole is applied evenly on the surface of the work with a circular motion. This polish dries quickly, and when dried out more of it must be applied to the rubber as before. Porous wood will take up a great deal of it, and if economy is any object, a thin coat of size may be put on to fill the pores previous to French polishing. Two or more applications of the polish, thinly applied, will show more finely than one thick coat.

How to apply the polish.

671. The artisan will find it expedient to use judgment in the finish of his work, and not use polish, oil, or varnish indiscriminately. Some work looks better with the plain wood, while a true idea of art would dictate further manipulation only when some more beautiful effect can be produced, exhibiting more clearly the grain or the colour of the material. Raw linseed oil may be frequently used to good purpose. It should be applied in limited quantity, so that the surface shall not present a greasy appearance. The pores of the wood having become filled, scarcely any further application is necessary. A mere shiny appearance should be strictly shunned in every case. French polishing cannot be well performed

Judgment necessary in finishing work.

with a brush, as the process depends altogether upon patient and continued rubbing.

672. The fret-saw attachment to the Eureka lathe has already beer noticed, and it now only remains to speak of the Rogers Fret-saw, which is the best cheap machine in the market, and one with which the amateur would do well to provide himself, as he could scarcely make himself one at less than the price which Messrs. Churchill and Co. ask for it, which is only 17s. 6d.

The Rogers Fret-saw.

673. If the reader has carefully perused the description that has been given of a home-made fret-saw treadle machine, he will readily recognise the various parts shown in fig. 338 and their uses. The machine is provided with a drilling attachment and iron table, adjustable for inlaying. All the working parts are of iron and steel, and its weight, with box, is not more than 40lbs. It should be said that the iron and steel parts are polished or japanned, and the woodwork that enters into its construction is painted a dark colour. The height of the table above the floor is 32in. The larger belt-wheel is 12in. in diameter, and the smaller balance-wheel 5in. in diameter. The arms, which are 18in. in the clear, are furnished with the latest improved clamps for holding the saw. The driving belts, extra drills, and a wrench are supplied with each macnme.

Description of machine.

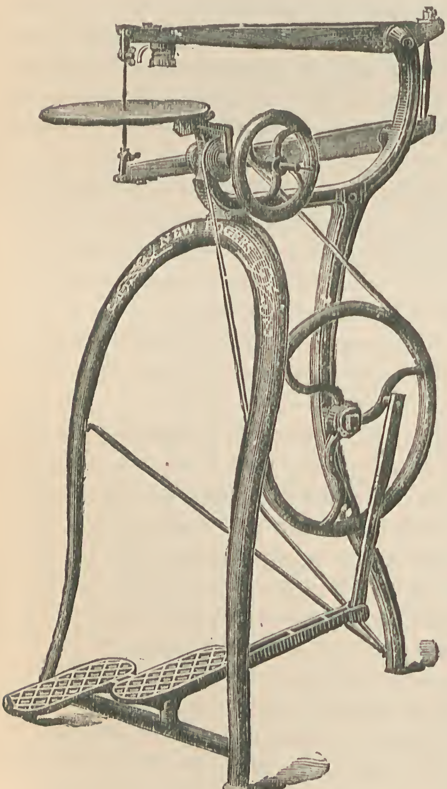


FIG. 338. THE ROGERS FRET-SAW.

674. Fret-sawing, as the reader will have observed, and as we have

already taken occasion to remark, is a "study of outlines"—the diversification of a flat surface with perforations, the whole being bounded by a certain outline, but flat and without relief, exhibiting a perfectly level surface throughout. For relief in the ornamentation of the surface in any material such as wood and stone, but more especially wood, we must resort to carving, success in which can only be attained by the aid of sharp tools, natural tact, a steady hand, and patient love for the art.

Fret-sawing a study of outlines.

675. Indeed, "patient love for the art" is the only price that can be paid for success—the only coin, so to speak, by which it can be purchased. There is no speedier way to achieve it. Every little chip must be cut for a purpose, either to mar or to beautify the work, and he who is unwilling to tax his time and patience over each tiny line of depression had best avoid carving. Capacity itself cannot be purchased; it is a result of industry, energy, and will.

Success must be bought with patience.

676. The tools have already been described, and an endeavour must now be made to tell the reader how best to use them; but, as it has been said with respect to the tools used in ordinary carpentry and joinery, a little showing is worth any amount of telling, and an hour spent in watching a carver at work will do more towards helping a would-be carver to a proper notion of how to handle his tools than any number of pages of careful and elaborate description.

How to learn to use tools.

677. Let us suppose that the object in view is a carved letter-rack, for which a suitable design is given in fig. 339. The rack consists of five pieces—the back, solid in the centre, and surrounded with a frame and scroll work of leaves, and four pieces perforated, as shown in the design, and fixed to the back one above another at a very small angle. Such an article would look well carved in white holly wood, with the background within the frame formed of a piece of black walnut wood let into the white frame, or the white wood depressed *within* the cross bars that compose the framing, and covered with a piece of ruby, green, blue, or black velvet. The pieces in front of the rack and fastened to it for the purpose of holding cards, letters, etc., are also made of white holly, if this be the material used for the back of the rack.

Carved letter-rack.

678. Now it is manifest that the first thing to be done is to make a tracing of the design and fasten it with paste to the pieces of wood that have been selected, and next to cut out the outline and perforations in each piece with the saw. The appear-

Preliminary proceedings.

ance presented by the pieces of wood will then be that exhibited in the lower part of the illustration, which presents an appearance of solidity and substance that is common to fret-work pure and simple without any extra embellishment by aid of the carving tools. The reason of this is, that the whole of the flat upper surface meets the eye, but as soon as the edges of the various parts are taken off and the leaves are

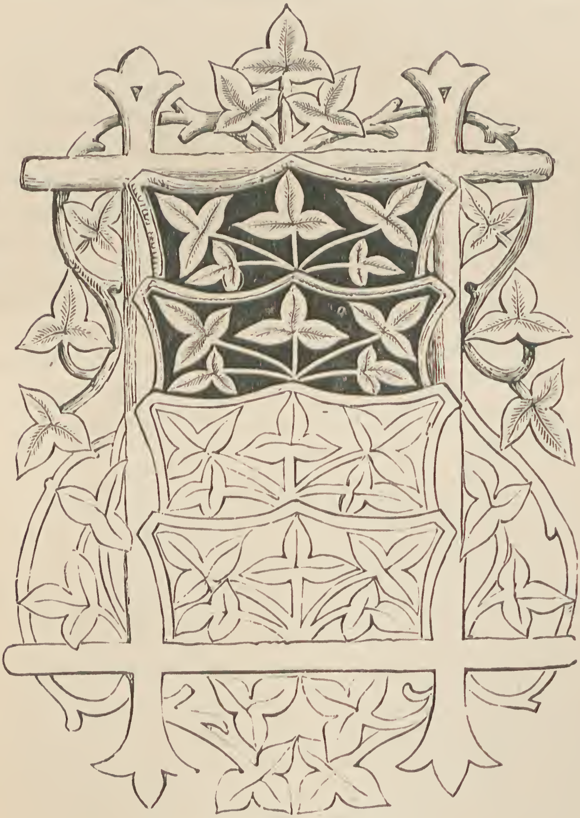


Fig. 339. Carved Letter-rack.

chiselled out and sloped from the veining in the centre to the edge, as shown in the upper part of the illustration, roundness is given to the various parts, the harsh squareness of the outline is removed, and some parts are brought into light, and other parts thrown into shadow, giving an agreeable relief to the surface which before was to a certain extent monotonous.

679. Assuming, then, that the requisite attention has been paid to sharp edges, and that the rough outlines of the design here given have been cut out carefully with the saw, let us see how the carving tools may be applied so as to bring out the best effect. And, first, let us study the leaves. At the extreme points they have a slight curvature upwards, which, however, is not any higher than the thicker portion, or that which is apparently the thicker portion. This, perhaps, may be more intelligible on an inspection of fig. 340, in which A B C D represents the section of a leaf through the middle vein or rib. Now it will be obvious that the greatest reduction of surface exists between the points E and F and the points F, G, and D. The solid line E G D represents the course of the middle vein from the stem G D, this being the line of greatest depression in the middle of the leaf. From this the surface of the leaf rises, as shown in fig. 341, until F, represented by a dotted line in fig. 340, is reached when the surface falls until the greatest depression is reached at H, whence it rises slightly to the edge of the leaf E. Wherever a depression exists in a leaf we must begin by hollowing it out with the chisel, but only very gradually, for we must bear in mind that the surface of the leaf again slopes down from the edges, and it is far easier to cut away too little material, for more can always be taken away, while it is impossible to add any when more than is necessary has been scooped out. Expert carvers would use a gouge with a somewhat flat edge for such work, but less practised hands would find the skew-chisel a more convenient tool. The cutting should be done both ways from E and F towards H, the centre of the depression, following the grain of the wood as much as possible. With such work it is not necessary to observe a mathematical exactness in the outline; a little irregularity adds to the effect and prevents stiffness of appearance. This irregularity will be more requisite in carving such a design as that represented in fig. 340, because, while the outer edges of the leaves are somewhat rounded, the edges which join the frame will be almost angular, in order to throw them more into relief.

Application of carving tools.

The leaves.

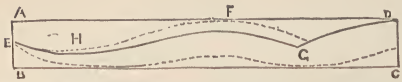


FIG. 340. LONGITUDINAL SECTION OF LEAF.

FIG. 341. TRANSVERSE SECTION OF LEAF.

Depressions in leaves.

680. The veining-tool must be used for marking the ribs, the larger one being made by cutting a double line from the stem, and then

gradually merging the two lines into one as you work towards the end, and then the lateral or side ribs are to be formed of a single line joining the centre or mid-rib. An attempt has been made to show this in fig. 342, in which a leaf, as shown in fig. 340, is represented on a large scale. These veins or ribs should not be cut deep, but distinct enough to show a clear, sharp line.

Ribs marked by veining-tool.

FIG. 343. TREATMENT OF STEMS.

FIG. 342. LEAF ON LARGE SCALE.

The surface of the leaf can be neatly smoothed with the mezzotint scraper — a tool which resembles a double-edged eraser — used in scratching out ink marks on paper, and which will be found more convenient for this purpose than sand-paper. The stems should be rounded but left rough, in order to preserve natural appearance, and the frame should be worked up in the same way; but as it is intended to be rustic, a series of fine lines should be cut upon its surface, as in fig. 343, in order to give it more roughness. The centre, if it be not covered with velvet, should be worked with cross hatching to match the rustic sides. Sand-paper should not be used at all for such work as this, and for the few occasions on which it may be absolutely necessary to use it, the carver will find it very convenient to cut out slips of rough wood, somewhat in the shape of files, to which strips of sand-paper may be glued. A clear clean cut with the tools will, in general, be quite sufficient. Whenever practicable, the work to be carved should be fastened firmly to a table, for both hands will be needed in using the tools. To accomplish this clamps of various sorts are used where the shape of the work will admit. A simple method of fastening down work to the surface of a table or cutting-board is shown in fig. 344, in which A is the table in section, B the work to be carved, and C a flat bar of wood, having holes at each end through which round-headed bolts D and E are passed. These bolts go through holes in the table corresponding with holes in

Treatment of stems.

Manipulation of centre.

Sand-paper.

Fastening down work.

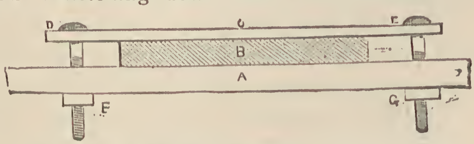


FIG. 344. CLAMP FOR FASTENING DOWN WORK.

the bar, and the bar is brought down tightly on the wood so as to hold it securely by screwing up the nuts F, G. It is an essential point to have the work immovable, except at the will of the carver. The tool, when in use, should be guided by the fingers of the left hand while it is pressed forward by the palm of the right hand, which should rest on the top of the tool handle. Thus steadiness will be given to the tool, and if the steel is good and the edge sharp, the cut will exhibit a corresponding smoothness.

Guidance of cutting tool.

681. Carving is a slow process, though so beautiful in its results. The rules are few, and the art difficult to explain; practice illustrating it vastly better than precept. But however true this is, some plain and general directions may be given for the guidance of the amateur carver, leaving it to his judgment and intelligence to make such variations and applications as mechanical tact may indicate as being necessary.

General directions for amateurs.

682. First with regard to *outline*, or *contour*. This should always be devoid of stiffness, and a graceful, natural appearance preserved. Intersections of stems should be neatly worked out, by cutting away a portion of the wood on each side of the under stem where the upper one crosses it. The depression must not be too abrupt, lest it seem like a dent made purposely, but the line of slope should be begun far enough back from the point of junction to allow a harmonious blending, and show a distinction between each stem.

Outline, or contour.

683. With regard to the *direction of the cutting*, or, in other words, the direction given to the tool, this should be invariably *down* and not *up*—away from and not towards the higher surfaces. This will be governed by the grain of the wood. The material, as it has been said, is always strongest in the direction of the fibre, and wherever a good strong purchase can be maintained it is best to render it available. Care should be taken not to splinter the surface. No more force must be used than is just sufficient to separate the chip without detaching any adjacent fibre; in other words, the work is to be done altogether by cutting, and never by rending.

Direction of cutting.

684. The carver must have complete command of his tools. He will sometimes find it expedient to use his chisel with the bevelled end upwards, which will cut away only a thin shaving as the direction of the edge is thus changed and it is not able to enter the wood to so great a depth, and the chip is rather like a fine shaving made by a plane. By this simple plan a great deal of carved work can be wrought more easily with a chisel than with a gouge.

Carver must have command of tools.

685. The mezzotint scraper, of which mention has been already made, and the shape of the head or scraping part of which is shown in fig. 345, will be found useful in accordance with its name for making smooth such surfaces as require its action, its shape adapting it to a variety of modes of applying it. It is not in the quantity of tools that true skill consists. A clever workman will often do better work with one simple tool than others will with twenty.


FIG. 345. MEZZOTINT SCRAPER.

Mezzotint scraper.

686. Carving tools, because of their shape and the necessity of having them well tempered, are more expensive than similar tools of their class ; or perhaps it should be said, that it is better for the amateur carver to buy good carving tools, and but a few of them, and give a good price for them, than to provide himself with a great many at a cheap rate. Such tools may be had at all prices, but it is always more economical in this case, as in many others, to buy the best, as these will prove the cheapest in the end. The following are the average prices of good and reliable carving-tools, and they may be purchased at these rates of most dealers in this class of goods :

Carving tools, and their prices.

	s.	d.
One dozen Files in leather case, assorted	1	6
Carving Chisels, Gouges, etc., of all kinds, from 6d. each to...	1	6
Best Stone Slips for sharpening carving tools, from 1s. to	1	6
Chequering Punches, Star Punches, etc., each	0	6
Small Table Cramps for securing work to table, each from	1	6
Small brass Hinges, with screws, for folding brackets, etc., per pair	0	2
Wood Varnish, per bottle 1s., or twice the quantity in stone bottle	2	0
Japanned Tin Case for pocket, containing six Carving Tools, Oil-stone Riffler, Star and Chequering Punch	14	0
Casec ontaining Saw-frame, Brace and Bit, six dozen Saws in Leather Case, one dozen Files assorted, one dozen Gouges and Chisels for solid carving, Bottle of Varnish, Star Punch, Chequering Punch, Oil-stone and Spring-vice	60	0
Mezzotint Scrapers, each	0	6
Rifflers, each about	1	6

687. No mention has been made of the star and chequering punches and the riffler, and the purposes to which these tools are put may need some little explanation. The riffler is in point of fact a variation of the file, each end being bent and ridged as in fig. 346. The end of the tool being curved can be introduced into corners and crevices into which the ordinary file cannot penetrate. The punches are intended for imparting a rough appearance to the ground-work on which is a raised pattern of diaper or other work, the interstices between the pattern having been cut away, leaving the pattern in relief on the ground that is thus worked with the punch.

Star and chequering punches, and riffler.


FIG. 346. RIFFLER.

688. A few more remarks on the general mode of procedure to be adopted in cutting out work, and bevelling edges, and putting work together, will bring our necessarily brief notice of fret-sawing and wood-carving to an end ; and with some observations on inlaying and overlaying as branches of fret-sawing, and on curving solid objects in wood, we must bring to an end our remarks on the theory and practice of Ornamental Carpentry and Joinery.

General mode of procedure.

689. The method of holding and managing the hand saw-frame, and where to begin in cutting out a design in fret-sawing, first require our attention. The hand saw-frame requires all the steadiness obtainable. The tail of the frame should rest along the fore-arm, and against the shoulder if the frame be a long one, or under the shoulder if it be short. This will prevent the frame from swinging round and bending the saw-blade, and so causing it to cut crooked. The saw will actually dip or describe the arc of a circle as it passes through the wood, and this dip is reduced to the minimum by making short strokes instead of long ones. Thus will plainly appear the great superiority of treadle machines, which possess this steadiness in a greater degree, being fixed at those points where the support of the workman's arm and shoulder would be otherwise necessary, leaving both hands free to guide the work.

Holding and management of the saw-frame.

690. Saw-gates, or holes for the entrance of the saw, should in all cases be bored as near to an angle as possible. All the interior should be cut first, if possible, so that the surplus wood, round the outside, may serve as long as may be for a continuous support to the frailer portions. In cutting a circular or oval frame, for example, surrounded with scroll-work, it is generally best to begin at the top of the design, boring the saw-gate near an angle, and cutting in the direction of the line until the angle is reached at the junction of the two curves. Now run the saw back a little more than its breadth, turn it half-way round, and run it close down to the angle again. A very slight twist of the saw will now cause its cutting edge to catch upon the wood fibre as a cut is commenced upon another line. Having reached the points at the top of the line, a slight sudden twist of the saw will cause its teeth to catch and follow yet another line. Backing the saw would be useless in such a case, as the angle is not acute enough to allow it to turn round.

Saw-gates, or entrances for saw.

Interior of work to be cut first.

Manipulation of saw in cutting.

691. In looking carefully at the wood when a design has been placed on it, it will be noticed that some of the lines run according to

Grain of wood.

the grain of the wood. Such parts gain all the advantage of support from the grain at every point where the fibre of the wood is not severed or cut away, and wood is many times stronger on the line of its fibre than in any other direction. It will be further noticed that other lines of the work run across the grain, especially the little projections or horns on the outside edge of the frame. These being the weaker points, all the adjacent support which they depend upon for most of their strength must not be removed too soon. If the weaker portions are cut away first, whenever practicable, the support will be decreased gradually, and the danger of breaking will be diminished. The outer edge of the design obtains an abundant support from the waste wood of the margin which, at the same time, contributes somewhat to the strength of the interior portions, therefore this waste wood should be cut away the very last of all.

Care necessary in cutting design.

692. It must be remembered that the saw-blade is frail and easily snapped, and that the material should not be fed to it any faster than the teeth will cut. When the saw-blade is in action the simple pressure of the fingers is all that is required for holding the work to the table, and moving every part of the line to be cut in due succession against the cutting edge of the saw. The eye should be fixed upon the point where the saw-blade is operating, and follow the line, so that there shall be no deviation, for the mazy outlines will distract and puzzle the vision that wanders all over the design.

Feeding material to saw.

693. Many a good fret-sawyer, who can cut out work in the best manner possible, finds great difficulty in putting together the various parts of which it is composed, especially when they slope at an angle to one another. It is frequently requisite to join portions of work together when the appearance of the joint is objectionable. To avoid this as much as possible a knowledge of the relation of angles to each other must be acquired. By the accompanying plan of a hexagonal basket, shown in fig. 347, it will be observed that if the sides were set up just as they are, they would meet each other only on the inside edge, while on the outside quite a

Putting parts of article together.

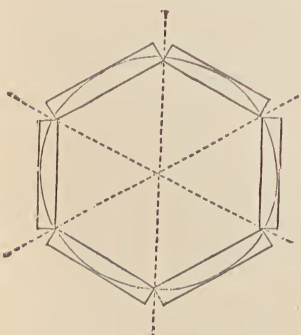


FIG. 347. PLAN OF HEXAGONAL BASKET.

separation would appear; therefore a proper angle must be made by sloping the inside edges sufficiently to make a close fit, and this process, which has been explained in section 461, is technically called bevelling, or mitring.

Bevelling, or mitring.

694. The method of determining the degrees of different angles is very simple. In the case of such a basket as that which is indicated in fig. 347, measure the distance between the outside edges from the point A to the point B, as shown on a larger scale in fig. 348, while the sides are held together in proper position. This will show the exact amount of bevelling the pieces will require, but you must divide it equally between two sides of the basket, so that each may have an equal share. A small pair of compasses will be found convenient for determining the measurement, and then, calculating the exact half, mark it off from the inside edges of each piece, when the surplus material can be cut off with a saw or shaved down with a sharp chisel. Now this, although it will answer well enough for very thin pieces of wood, is not an exact method, for reasons which will be obvious at once to any one who understands geometry; for from an inspection of fig. 348 it will be seen at once that A B, or half the distance between A and C, is less than the distance from D to F, at which the line marking the limit of the bevel or mitre should be marked on the inner surface. Let the pieces be put in the position they are to occupy, as F D A, C D E, and trace the plan on paper with a fine-pointed pencil. Then divide the angle A D C into two equal parts, which is easily done by producing the lines indicating the outer surfaces of the boards in the direction A G and C G, and drawing a straight line D G through the point D, where the inner surfaces touch, and the point G, the point of intersection of the outer surfaces produced. Then, if lines be drawn through A and C, namely A F and C E, parallel to D G, these lines will indicate on the plan the extent to which the edges F D A, E D C, must be cut away in order that the sides may be joined together closely and accurately; or, what is the same thing, distances D F and D E, equal to A G or G C, may be measured from D along the inner surface of each board, thus indicating the extent of the bevel.

Determining angles of bevels.

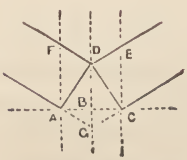


FIG. 348. BEVELLING EDGES OF THIN BOARDS.

Method to be employed.

695. Inlaying is the art of cutting out pieces in one piece of wood, which may be termed the ground, and filling them up with pieces of wood of a different colour, or with pieces of ivory, tortoise-shell, or metal. When wood is used the work is called

Inlaying.

marquetry, and when metal, etc., is used it is termed buhl-work. Both kinds of work are used in the ornamentation of furniture, desks, workboxes, cabinets, etc., and fall within the province of the fancy cabinet-maker.

Marquetry and buhl-work.

696. The extreme nicety required in performing the operation of cutting out marquetry will deter most amateurs from attempting it; but supposing that he is determined to do so, he must procure two pieces of veneer of different colours, and after pasting a piece of stout paper on the inlay part, to fasten the two pieces of wood together with very short and very fine wire tacks, to prevent them slipping one from the other. It is necessary to make the cut through both pieces of wood slightly on the bevel, and for this purpose a bevelling attachment is added to some treadle machines, so as to keep the table on which the work is cut at a suitable angle. The inlay, in consequence, will be somewhat wedge-shaped, and a trifle longer than the hole which is cut to receive it, the sides of which will also be on the bevel. A hole must be made for the entrance of the saw, sloped in such a way as to pass through the waste wood, both in the ground and the inlay; and when the saw has been introduced, the pattern must be steadily followed until the whole of the cut, however intricate it may be, has been made. A slight blow with a wooden mallet will suffice to drive the inlay into the ground; but before doing this, the inlay should be touched at the edges with a little thin glue. The work is finished by scraping the surface with a cabinet scraper—a small square plate of steel with a sharp edge—to bring it exactly level, and then rubbing it over with very fine sand-paper, and polishing it if necessary.

Mode of procedure in cutting marquetry.

697. The reverse of inlaying is overlaying, a process much more simple, yet quite as amenable to the principles of symmetry and taste. The design will stand in relief or raised from the ground, and is often susceptible of further embellishment by means of the carving tools.

Overlaying.

698. This kind of work has been already spoken of in the first chapter as a useful and easy means of decorating flat surfaces, such as the facias of window cornices, the styles, rails, and panels of doors, the doors and framework of cupboards, and the sides of book-cases. A variety of figures can be cut out from thin board, which being firmly glued and bradded or pegged to some flat surface may be wrought with the carving tools, and appear to as good advantage as if carved from a solid piece. It would be far less labour than to reduce the surface from around the ornament.

Application of this process.

699. The surface to be decorated having been carefully prepared and planed true, the design must be cut out by the fret-work saw, and

Production of overlay.

attached to the surface destined to receive it. For a cornice over a window the Greek key pattern (fig. 349), as it is called, or the "guilloche" ornament (fig. 350), would be appropriate, or a pattern of leaves and tendrils running from end to end: for a panel four corner-pieces, similar in shape with an ornament in the centre. The good taste of the amateur, taking into account the purpose to which the article thus adorned is to be put, will suggest to him many effective modes of decorating surfaces in this manner.

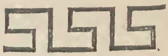


FIG. 349. KEY PATTERN.

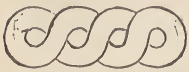


FIG. 350. GUILLOCHE.

Chief point to be remembered.

The chief point to be remembered is that the grain of ornament and ground-work should run in the same direction. Pretty effects may be obtained by contrast of colour—a pattern in white holly being placed on a ground of walnut wood, or

Contrasts in colour.

vice versâ. If the surface is covered with diaper work or with a thin board pierced with small quatrefoils, trefoils, etc., forming a regular pattern all over it, and the colour of the depressions and the parts in relief is to be the same, it will be better (supposing that the board to be decorated and the decorative work are both of some light wood, such as pine or silver fir, which is to be stained), to stain the ground-work before the ornamental part is attached to it. When this has been done, the whole must be touched over with staining, and finally sized and varnished. An ample field

Excellent decorative work for house.

for decorative work in every part of a dwelling-house is opened up by this branch of fret-sawing, and we are sure that many of our readers will not be slow to take advantage of it. An hour or two spent now and then in the preparation of the ornamental overlay, and a spare half-holiday or two devoted to fixing

Carved work at trifling cost.

it in its place, and the necessary work of staining, sizing, and varnishing, or even painting if it be preferred, will transform many an ugly door or piece of furniture into an elaborate specimen of richly-carved work at trifling cost.

700. There is but one thing more to be touched on in connection with wood-carving, and that is carving in the solid. Now carving in

Carving in the solid.

the solid will divide itself into carving in high relief, or even low relief, which in either case has a grounding of the same material, from which the carved work rises; and carving an object out of a solid piece of wood, every part of which is wrought over by the carving tools. A wreath of flowers hanging between two

sustaining points, or a dead bird or animal suspended to a nail or ring, may be taken as a good example of carving in relief; and the finial to the upright end of an open seat or bench in a church, commonly called a poppy head, may serve as a fitting illustration of the other.

Examples of carving in relief.

701. Suppose, for the sake of illustration, that it is desired to carve a boss in high relief similar to that figured at A in fig. 351. If it were but a single boss on a square piece of wood, the easiest mode of procedure would be to fix the wood to a chuck, and turn the surface in the lathe to the shape represented at B, which is the appearance the wood would have if cut in half vertically or horizontally —in fact, a representation of the wood in section after it has been turned; but if this cannot be done, the depth of the block must be marked by a line round the sides of the piece of wood, as from K to L in B, and the circle that the base of the boss will occupy marked on the top of the wood. Saw-cuts may then be made in the lines *a b*, *c d*, *e f*, *g h*, in A, nearly, but not quite, down to the marks along the sides, and the corners may then be removed by horizontal saw-cuts. Four more pieces may then be removed on the four sides of the piece of wood, as indicated by the dotted lines parallel to *a h*, *b c*, *d e*, *f g*, when the boss will be roughed out in the form of an octagon, which must be further reduced at the edges on all sides and round the top till it has been brought to a shape approximating to the semicircular section shown at B. This work must be carefully done with the chisel, and care must be taken to leave the hemisphere from which the boss is to be carved a little larger in every way than the boss itself will be when finished. The four leaves that enfold the central part of the boss with their edges slightly turned over, and the mid-rib running up each, must be drawn in pencil on the surface of the hemisphere, after which the work of carving will commence. The first thing to be done will be to hollow out the circular depressions at the points where the leaves join, and chisel out the interior of the boss, which is to be cut in chequers as represented. Next, each leaf should be so cut away on the outer surface so as to exhibit clearly the end turned over, and the mid-rib, after which the carving and bringing into proper form of the whole surface must be

Boss in high relief.

Mode of procedure in carving boss.

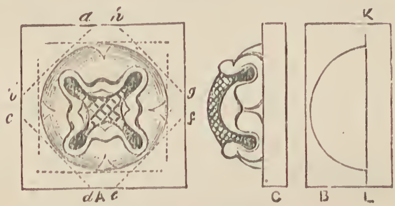


FIG. 351. MODE OF CARVING BOSS.

proceeded with gradually until the boss is perfectly developed in every part.

702. In carving from the solid on every side, as in the finial, or poppy head, represented in fig. 352, the first thing to be done is to trace on the outer and inner face of the wood the exact shape that the finial would present in section if cut down the middle vertically, as shown by the outline figured in A. Lines must then be drawn on the sides between the faces as in B, and by the aid of these and the outlines on the faces the superfluous wood at *a*, *b*, *c*, *d*, *e*, *f*, may be cut away leaving the ornament roughed out. The sides of the finial represented will be merely plain surfaces with the edges chamfered or cut away sufficiently to give the necessary roundness to either face, which must then be marked in pencil to show the parts that are to be cut away and the parts that are to stand out in relief. The whole must then be finished with gouge and chisel in the same manner as the boss above described.

Carving from solid on all sides.

Examples of finial.

FIG. 352. FINIAL, OR POPPY-HEAD.

703. And here our remarks on operations in Ornamental Carpentry must be brought to a close. The use of the various tools and machines employed in its various branches and the method of going to work with them have been described and illustrated. In the following chapters it will be sought to turn to good account much that has been advanced with reference both to simple and ornamental carpentry in describing and illustrating various pieces of work which may be grouped together under the broad and comprehensive title of Constructional Carpentry.

Conclusion of the subject.

CHAPTER V.

SIMPLE AND EASY CARPENTRY : FIXTURES, TEMPORARY AND OTHERWISE, WITHIN DOORS.

Constructional Carpentry—What is comprehended under Term—Blind-roller and Curtain-pole—Bracket and Cornice—Simple Articles for Practice—Flower-sticks —Thickness of Board—Compound Flower-sticks—Hat-rails, Clothes-rails, etc.—How to Fix Them—Mode of Making Rail—Wooden Pegs—Iron Hooks, Pegs, etc.—Nailing Rail against Wall—How to remove Rails without Damage to Wall—Objections Answered—Blinds and Blind-rollers—Where to Buy Blind-rollers—How to Make Them—Putting on Ends—Pins in ends of Roller—Supports of Blind-roller—Wooden and Iron Brackets—Hanging within Window Frame—Attaching Blind to Roller—Rack and Pulley—Completion of Fixing Blind—Patent Appliances for Blinds—Prices of Fitting—Venetian Blinds—Prices of Venetian Blinds—How to Make Venetian Blinds—Principles of Construction—How Raised and Lowered—Description of Contrivance—How to Secure Blind when raised—Cutting down old Blinds—Painting—External Sunshades—Principles of Construction—Method of Fixing—Curtain-poles—Diameter of Curtain-poles—How to Make Them—Attachment of Ends—Brackets for Carriage of Pole—Putting on Rings—Fixing Pole in Position—How to finish Curtain-poles—Cornices for Curtains—How to make Cornices—Rail within for Curtains—Cornice for Bay-window—Moulded Cornice—How to make it—Arrangements for support of Curtains—Iron Bars or Hooks—Brass Grooving and Button—Easy Mode of Drawing Curtains—Brackets and Shelves—What a Bracket is—Corbels—Principles of Construction of Brackets—Simplest form of Bracket—Angle Iron—Flanged Bracket—Bracket with Strut—Ornamental Brackets—Cast-iron Brackets—Wooden Brackets—Principles of Construction—Proper Union of Parts—How to Cut Strut—Fastening Mortise—Fixing Strut-bracket—Ordinary Bracket for Shelf—Connection of Bracket and Shelf—Plugging in Walls—Brackets for Garden Walls—Ledges or Shelves on Brackets—Ornamental Brackets—Shelf in Recess or Corner—How to Prepare and Fix Shelf—Cutting Shelf to fit against Wall—Operation of "Scribing"—Shelf wider than Recess—Brackets in Recess—Fixing right-angled Brackets—Brackets Handy in all parts of House—The Bracket-table or Shelf—Several parts of Table—How to make and put them together—The Shelf—The Rail—The Bracket—Rest or support for Bracket—Fixture of Flap, etc.—Brackets to let down against Wall—Passing the Bottle—Mantel-shelf—Gilt Nails for Mantel-shelf.

Constructional Carpentry.

704. The term "constructional" implies putting various pieces together, joining the bits of wood of which any article is composed by the aid of nails or screws only, or by means of the joints that are used in Carpentry. The methods of making these joints—by scarfing and halving pieces of wood together, or by mortise and tenon, or by dove-tailing—have been explained in

Chap. VII. of Part I. of this work ; and the amateur, having learnt to saw and plane wood with tolerable skill and how to make these joints, has to apply the knowledge that he has acquired to practical work, adapting in all cases the mode of procedure to the nature of the work.

705. If only two pieces of wood are joined together, no matter in what way, the work, in the strict sense of the phrase, belongs to Constructional Carpentry, and there is really very little that may not be brought under this term. For example, there is no construction, no putting together of parts in making a rolling-pin, which may be fashioned in a lathe, or by the aid of a plane alone, when the wood has been sawn out ready for planing down from a rectangular to a rounded or circular shape. Even a simple blind-roller is a piece of Constructional Carpentry, and so is a curtain-pole, for both have to be fitted with suitable ends—those of the roller for use and those of the curtain-pole for ornament ; but these may or may not be formed of pieces of wood of various shapes jointed together.

What is comprehended under term.

Blind-roller and Curtain-pole.

706. Again, a bracket to be movable must be joined together, and being of two pieces, at the least, comes under the denomination of Constructional Carpentry. So will a cornice, which may be used instead of a curtain-pole in some positions with good effect. It will be useful in this chapter to consider how to make articles of the kind that have just been mentioned ; and to begin with the simplest thing possible, we will, in the first place, glance briefly at flower-sticks and hat-rails, easy to make to be sure, but very useful, and then proceed to blind-rollers and curtain-poles, then to cornices, finishing up with brackets and shelves of all kinds.

Bracket and cornice.

707. Flower-sticks and rails, wherein or whereon to fix pegs of wood or metal for hanging coats and hats, are the simplest things to which the amateur can turn his attention, because nothing else but the saw and plane need be used in making them, as far as cutting-tools are concerned. The manufacture of either or both of these articles will afford good practice for the amateur in elementary work.

Simple articles for practice.

708. Flower-sticks may be square or round, according to the fancy of the maker. A round stick looks lighter than a square stick, but the latter is the stronger of the two, provided that the diameter of the one is equal to the width of the sides of the other, because there is more wood in it. In making flower-sticks the first thing to be done is to choose a piece of board, and plane it up nicely on both sides, after having cut it to the length required.

Flower-sticks.

Suppose some sticks are required for carnations, 2ft. in length. Take a piece of wood of this length and ⅜in. *full* in thickness and plane it up; then with the compasses divide each end of one side of the board into spaces also ⅜in. full in width, or even $\frac{7}{16}$in., so as to allow for saw-cuts, and, by the aid of a straight-edge, draw lines along the length of the board from one end to the other through the points of division. Saw the board into strips with a fine hand-saw, and plane up the rough sides of the rectangular slips thus obtained. Cut the top with a paring-chisel into a pyramidal form, and sharpen the end of each stick. This should be done in the winter months, and the sticks painted and put away for use in the summer. In making flower-sticks always use board of the thickness required for the width of the side of the square stick or the diameter of the round stick. Thus, if you want sticks 1in. square or 1in. in diameter use 1in. board, and if you want to make 1½in. espaliers or stakes for fruit trees use 1½in. board, always dividing the wood in spaces equal to the thickness of the board.

Thickness of board.

709. For flowers that require more support than can be afforded by a single stick, a compound stick may be made, as shown in fig. 353, consisting of two uprights, so to speak, connected by transverse bars. The sides should be closer at the bottom than at the top; they should be formed of pieces of wood twice as wide as they are thick, and holes must be bored in them to receive the pointed ends of the bars. Compound sticks of this description look better and lighter when made of wire.

Compound flower-sticks.

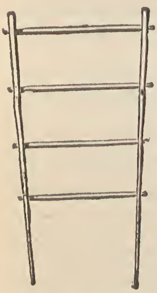


FIG. 353. COMPOUND FLOWER-STICK.

710. Rails with pegs attached for hats, clothes, etc., are always wanted in a house; and when the tenant or owner thereof, as the case may be, can use his tools, any special want of this kind may be speedily provided for. Rails may be fixed to walls by means of nails or to woodwork by screws; and they may be suspended by means of brass rings, somewhat stronger than those used for pictures. A rail should never be fixed across the inside of the door of a room, nor should nails be driven into the styles of any door, or hooks screwed on to them, for hanging clothes; for the weight of the clothes has a tendency to drag the door out of place, and prevent it from shutting closely against the stops as it should do. Let it be a fixed rule with every one never to fix rails, or drive nails into, or screw hooks to, doors.

Hat-rails, clothes-rails, etc.

How to fix them.

711. A rail for the purposes above mentioned is simply a piece of wood from ½in. to ¾in. thick, and from 3in. to 3½in. wide, and as long as may be necessary. The face or front, sides and ends, must be nicely planed up, and the *arris*, or sharp edge formed by the meeting of the front with the sides and ends, must be chamfered or taken off with the plane, as shown at A, fig. 354, or rounded with a beading plane, as shown at B. Both these figures are in section. At C is also shown the old-fashioned way of making the peg in wood, and fixing it to the rail by letting one end into a hole made by a stock-and-bit for its reception. Pegs of this description should be turned in a lathe, by which means the knob at the end and the shoulder which butts against the rail can be more easily formed. At D is shown the double metal-hook for hat and coat. There are a great variety of these, single and double, made in iron, brass, and bronze, or metal coloured to imitate bronze. Brass hooks are often furnished with porcelain knobs, but the bronze hooks are neater, cheaper, and more serviceable. The old-fashioned straight iron peg, bent at an angle to the heart-shaped plate, in which are holes for the passage of screws to fix it to the wood, is shown at E and F, the former representing the side view, and the latter the plate when viewed from the front. Japanned iron hooks of this kind may be bought at 1d. and 2d., according to size. At G is shown a useful kind of single hook for hanging clothes, costing about 1d. or 1½d.; and at H, a small double hook—the hooks turning from the face in opposite directions—which cost about 9d. per dozen. Bronze hooks of the description shown at G, or similar in shape and purpose, cost about double the price of the iron or japanned hooks; and excellent double hooks, as shown at D, in different patterns, may be bought at prices ranging from 3d. to 6d. Every description of hooks, and all kinds of ironmongery required as fittings in houses, locks, etc., of English and American make, may be obtained, both good and cheap, of Mr. Melhuish.

Mode of making rail.

Wooden pegs.

Iron hooks, pegs, etc.

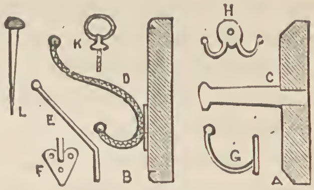


FIG. 354. HOOKS, PEGS, ETC., FOR RAILS.

712. A rail may be nailed against the wall with two or more brass-headed nails, as shown at L, or it may be hung to a couple of these nails by means of brass rings, as at K, screwed into the upper edge of the rail. The nails should slant upwards when driven into the wall, so that the rings may not be drawn up to

Nailing rail against wall.

and against the head of the nails by the weight of the clothes, etc., that may be hung to the hooks. The benefit in using rings lies in the fact that the rail may be easily and quickly moved from its place whenever it may be found desirable to do so. A rail is certainly more firm and stable when nailed to the wall, but much damage is frequently done both to the wall and the rail when the latter is taken down, as, for example, when moving from one house to another. All rails or strips of wood nailed to walls must of necessity be removed by the aid of a screwdriver used as a lever, and any injury either to rail or wall may be prevented by pushing the steel blade of a carpenter's square between the board and the wall to afford a resting-place for the end of the screwdriver—a fulcrum, in fact—while the process of lifting or prising the rail from the wall is going on. If the wall furnished the fulcrum, the point of the screwdriver would sink deeply into the soft plaster and do much damage ; but when it is rested against the broad blade of the square, the pressure is distributed over the whole breadth of the square, and so prevented from doing any injury to the wall.

How to remove rails without damage to wall.

713. Possibly some of our readers may say, "This is not carpentry!" It is not so as far as actual working in wood is concerned ; but, as the object of this work is to give practical assistance to every man who is seeking to become his own mechanic, no apology is necessary for going into these points of detail, which, if they are not mentioned, may altogether escape the notice of the amateur, or be learnt only through the long experience of many years.

Objections answered.

714. Nothing is more comfortless than a room without a blind, and one would think that, instead of leaving it to the last, as five people out of six certainly do, the first thing thought of and done on entering a new house, if only for the sake of privacy, would be to put up the blinds. Let us see how to make a blind-roller, and how to attach to the roller itself and the frame of the window the necessary fittings to support the blind, and to raise or lower it at pleasure.

Blinds and blind-rollers.

715. Blind-rollers can be bought, generally speaking, of the oil and colour man, with the fittings for the ends, at prices varying from 6d. to 1s., according to length ; the amateur, however, can make one as easily and as quickly as he can a flower-stick. A straight-grained, clean piece of deal having been selected, about 1in. or 1¼in. in thickness—it must not be thicker—a piece just as wide as the wood is thick must be sawn off of the necessary length.

Where to buy blind-rollers.

The transverse section of this piece of wood will be a square, and the four arrises or sharp edges must then be planed off, as shown at A, in fig. 355, so as to make the wood octagonal or eight-sided instead of square; before doing this, however, the sides of the wood should be planed up. There is no necessity whatever to make the roller round, but the amateur can do this if he prefers a

How to make them.

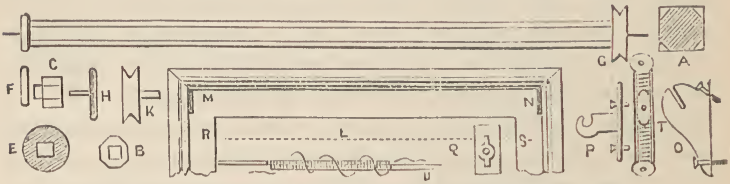


FIG. 355. THE BLIND ROLLER AND ITS DIFFERENT PARTS.

round bar to an octagonal one. Each end of the roller must then be *keyed*, as shown in plan at B, and in elevation at C, in order to fit into square holes cut for their reception in two pieces of hard wood, one of which is thin and the other grooved like a pulley. The plain end is shown in plan at E, and in elevation at F, and the grooved end at G, in the drawing of the roller when complete. The object of the *keying* is to prevent any chance of the grooved end being turned round by the blind cord without carrying the roller round with it. The plain end should be attached to the *left-hand end* of the roller, and the grooved end to the *right*. Brads may be driven through the ends to fasten them more securely to the roller, but if the keying has been properly done this will be unnecessary. Two pieces of strong iron wire must then be driven in, one at each end of the roller, as pins on which the roller may revolve. Care should be taken to drive these precisely into the centre of each end, and in such a manner that the two pins may be exactly in one and the same straight line. If they are not so the roller will not revolve easily, but have what is termed in engineering an *excentric* motion.

Putting on ends.

Pins in ends of roller.

716. We must next consider how the blind-roller is to be put in the position it is to occupy. It is usually supported on a couple of brackets, but it depends very much upon circumstances how and where these brackets are to be fixed, and what kind or form of bracket it will be most convenient to use. Supposing that the window is an ordinary window, that is to say, a frame finished on the outside edge of the inner face with a moulding as shown at L, the proper places for the brackets will be just within the mouldings, in the positions M and N. To insure accuracy in ascertaining the length

Supports of blind-roller.

of the roller, it will be better for the amateur to screw up his brackets first, and then measure off the extreme length between them, allowing when cutting the roller not less than ¼ in., and not more than ½ in., so that the roller may work freely when suspended by means of the wires at either end on the brackets. The brackets are, when made of wood, usually of the shape shown at O, and when of iron, as at P. In these illustrations the brackets are shown in which the pulley end of the roller is placed, a slit being made in the wooden bracket and a hook in the iron one, into which the wire is dropped. In the brackets for the other end a small hole is made for the reception of the wire, and in putting up the roller the wire at the plain or left-hand end is first put into the hole in the left-hand bracket, and then the wire at the other end is lifted over the right-hand bracket until it is high enough to drop into the slit or hook. When put in its place the roller should be turned quickly with the hand to ascertain if it works easily. The brackets are fixed with screws, as denoted in the illustrations.

Wooden and iron brackets.

717. Sometimes it is necessary to hang the blind *within* the window-frame, that is, in the position shown by the dotted line R S; when this is done the wires of the roller are supported on small brass projections semi-globular in shape, screwed on to flat pieces of wood, as at Q, just wide enough to fit the groove between the outer board of the frame and the parting slip, within which the *lower* sash-frame works up and down.

Hanging within window-frame.

718. When the brackets are fixed and the roller works easily and truly on them and within them, the next thing is to nail the blind itself to the roller. Before doing this slip the upper end of the fabric over the roller, moving it one way or the other as may be necessary until the blind hangs straight down from the roller, inclining neither to one side or to the other. Unless this precaution be taken the chances are that the blind will be crooked, and not roll up and down fairly within the plate or disc on the left-hand end and the pulley on the other end. The rack and pulley, T, to carry the blind-cord must now be screwed on to the window-frame, and the cord itself passed through the *lower* part of the pulley, cut to the proper length, and sewn. There is some little art even in sewing the ends of a piece of blind-cord together. The ends should be lapped one over the other as shown at U, and sewn through and through in the manner indicated by the serpentine line. When firmly connected in this way the overlapping ends should be tightly overlaid or bound over with thread all along the joint, which

Attaching blind to roller.

Rack and pulley.

when made in this way will be found to be a strong one, and one that will work easily over the pulley of the roller and the pulley of the rack. To complete the fixing of the blind all that is now necessary is to lift the pulley end of the roller out of its place, slip the cord over it, re-insert the wire in the bracket, and then slip the catch and pulley down the rack, taking care not to strain the cord too much, but merely to tighten it sufficiently to work the blind up and down.

Completion of fixing blind.

719. The method above described is the ordinary mode of making and fixing house-blinds. There are patent appliances, spring rollers, etc., by which a blind may be run up in a moment; but, as a general rule, these can only be properly fixed by an experienced hand. The amateur will find much difficulty in fitting them and making them work, in the first place; and in putting them to rights if they get out of order. Ends for rollers, whether of wood or iron, may be bought at the rate of 2d. or 3d. per pair, and iron brackets, galvanised, at the same rate. Wooden brackets the amateur may make for himself out of ½in. mahogany. Blind racks of an ordinary kind cost from 6d. to 1s. or 1s. 6d. It must be remembered that, simple as it all seems, considerable care and skill are required to hang a blind in a satisfactory manner, and the amateur must not be discouraged if his first efforts in this direction are not crowned with success.

Patent appliances for blinds.

Prices of fittings.

720. The prettiest kind of blinds for houses, undoubtedly, are Venetian blinds. They present a nice appearance outside the house, and modify the light within the room in which they are fixed far better than the common blind; for the degree of light to be admitted can be regulated at pleasure, by bringing the laths of which these blinds are composed closer together or further apart by means of a cord attached to the topmost lath for this purpose.

Venetian blinds.

721. Venetian blind making may be said to be a trade in itself, or at all events a special branch of carpentry, as in all parts of London men are to be found who seldom do any other kind of work but this. The lowest price charged for making Venetian blinds is 7d. per superficial foot, which includes all the fittings; but in general the carpenter who gives his attention chiefly to making blinds of this description will charge from 9d. to 1s. The amateur will be disappointed if he expects to get a *narrow* Venetian blind made for 7d. or even 1s. per foot. It is manifestly out of reason to expect a carpenter to make a blind 6ft. long and 1ft. wide for 3s. 6d., for the labour and trouble involved are very nearly as much

Prices of Venetian blinds.

as are required to make a blind four times the superficial area, that is to say, 6ft. long by 4ft. wide. The amateur will do well to order his Venetian blinds of such a maker as MESSRS. J. AVERY AND CO., 81, *Great Portland Street, W.*, and then, when he has got them home, to fix them himself, which is easy enough.

How to make Venetian blinds.

722. If, however, he is determined to do this kind of work for himself, the best thing he can do is first to buy an old Venetian blind of a dealer in second-hand goods, and study its construction thoroughly; taking it to pieces, putting it together again, and repairing it and getting it into working order. Secondly, unless he have plenty of time on his hands, and can devote enough of it to accomplishing the task of sawing his own laths, he had better, when about to make a new blind, purchase his laths already sawn. He has then nothing more to do than to cut them into pieces of the necessary length and plane them up.

Principles of construction.

723. Roughly described, the Venetian blind may be said to consist of a number of laths placed in two or more ladder-like cradles, each formed of two broad tapes with transverse tapes between them, like the spokes of a ladder, to sustain the laths. The ends of these tapes are secured at top and bottom to two thicker laths, and by means of a cord, the ends of which are nailed to the topmost thick lath, the laths may be opened or closed at pleasure. Fig. 356 will serve to show the principle of the construction of the Venetian blind; A and B are the thick laths at top and bottom to which the tapes C, D, E, F, are fastened. The laths G, H, K, rest on transverse tapes, whose direction is shown by the dotted lines, and which are attached to the broad, vertical tapes. The transverse tapes are narrow, and are sewn to the vertical tapes alternately, one being brought to one edge, and the next in order to the other. The laths G, H, K, as it has been said, are free to a certain extent, and rest on these tapes. The cord L M is attached to the topmost lath, A, one end to one side, and the other to the other side. Now it is manifest than when the side L is pulled downwards, the front edge of A is depressed, and the back edge raised; and the motion being communicated to the tapes, and thence to the intermediate laths, G, H, K, and the bottom lath B, every one of these will assume the position taken by A. Similarly, if M be pulled down the front edge of A will be raised, and the back edge lowered, and this will be the case with all the other laths. According to the

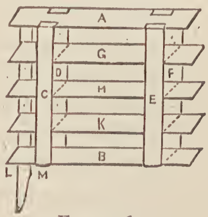


FIG. 356.
VENETIAN BLIND.

extent to which the cord L M is pulled, the position of the laths may be altered from a level or horizontal position to one that is almost vertical, and the openings between the laths increased or diminished so as to admit or exclude the light at pleasure.

724. This, however, does not explain the means by which the Venetian blind can be raised or lowered : it only describes the construction

How raised and lowered.

of the blind itself, and the manner in which the laths are sustained and put together; the means of raising and lowering the blind are altogether independent of this, and will be better understood by the aid of another diagram. Fig. 357 represents in plan a piece of wood the length of the laths of the blind, and about 1in. in thickness.

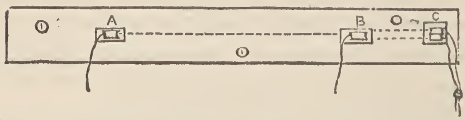


FIG. 357. LATH TO WHICH VENETIAN BLIND IS HUNG.

Holes are cut in the laths, just midway between the space covered by the vertical tapes, and a cord is passed through these

Description of contrivance.

holes, the lower end being attached to the bottom lath ; the common mode of doing this being to make a hole through the lath, pass the cord through it, and make a knot at the end so that it may not be withdrawn. When there are only two tapes, arranged vertically, or, to speak more strictly, two pairs of tapes, two cords are used ; but if the blind be wide, and three pairs of tapes be used, three cords will be required for strength's sake. The cords are passed up through the holes in the laths, the tapes falling alternately, one on one side of the cord, and the next on the other side. In the thick board shown in fig. 357, two slots, corresponding to the position of the tapes and cords, have been cut at A and B, and in these slots small pulleys are fixed. A third slot is also cut at C, wide enough to receive two pulleys, or even three, if necessary. The blind is attached to this board by means of short tapes or bands, just long enough to allow the topmost thick lath to be turned either way without coming in contact with the lower face of the board ; the cords are then passed over the pulleys A and B, and, after running along the top of the board in the directions shown by the dotted lines, are brought out over the pulleys inserted at C, and knotted together. Of course it will be readily seen

How to secure blind when raised.

that when the blind is down, by pulling these cords it can be raised ; and, *vice versâ*, by slackening the cords it can be lowered. The board is attached to the upper part of the window-frame by screws, but care must be taken not to turn the screws in too tightly lest the cords be pinched between the board and the

framing of the window, and prevented from working properly. When the blind is raised the cord is secured by passing it round two hooks turned in contrary directions, and screwed to the wood-work of the window in some convenient position. This is the whole art and mystery of making Venetian blinds. It may answer the amateur's purpose to cut down old blinds to fit smaller windows, or to re-arrange the laths; but, unless he has a great deal of time at his disposal, it will hardly *pay*, as the phrase goes, to make new ones. Of course, before the blind is put together and fixed in the position it is to occupy, the laths and board must be painted emerald green, pale blue, or some other colour, according to the maker's fancy, or they may be simply stained and varnished. The stained laths, however, are not so pleasing in appearance, either within or without the house, as those that are painted.

Cutting down old blinds.

Painting.

725. External sunshades for windows are made in some measure in accordance with the mode adopted for raising and lowering Venetian blinds. First of all, a screen of thin wood, A B C, which serves as a protection for the blind when drawn up, is fixed within the reveals of the windows. Two rods are then made, either of wood or iron, and fixed one on either side of the window. A piece of iron bent so as to form three sides of a rectangle, as shown at F, is fitted with rings, so as to work up and down on the rods D and E. Some strong material, usually striped, is then made up in the shape indicated by the figure, having a straight piece in front and triangular sides. Small brass rings are then sewn to the front piece, in the centre and at the sides, as indicated by the dotted lines G, H, K, and larger rings are sewn to the straight sides of the triangular pieces that they may attach the blind to the rods and work up and down at pleasure. Strings are then fastened to the iron F, and passed up through the rings in the direction of the dotted lines G, H, K. These cords pass over pulleys in a board fitted within the reveal of the window at the top, in the same manner as in the Venetian blind, and by these cords the blind can be raised or lowered at pleasure. When the cords are pulled the iron frame F is first raised into an upright position, and then is pulled up—frame, blind, and all—within the boarding A B C. Fig. 359 will make it perfectly clear to the reader how the frame-

External sunshades.

Principles of construction.

Method of fixing.

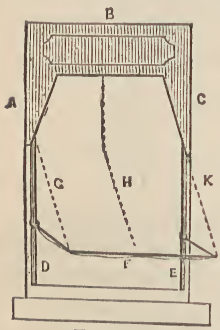


FIG. 358.
SUNSHADE.

work is attached to the rings that work up and down the rods by the side of the window. A stout pin, A, is attached to the ring B, and a hole is made in the end of the frame C. The pin is passed through this hole, and the head is beaten flat in the form of a rivet. Thus the frame works on the pins of the rings with an upward and downward motion.

FIG. 359.

Curtain-poles.

726. Curtain-poles may be purchased at a very cheap rate. A slight pole, suitable for an ordinary window about 3ft. in width, with the requisite rings and ornaments at the ends, costs about 3s. The amateur, however, may make excellent curtain-poles out of good red deal, and furnish them with ends that he can turn himself if he has a lathe. If he has not got one, he must purchase ends of wood ready turned to his hand, or metal ends of the ironmonger, of whom he may also procure curtain rings to suit the pole.

Diameter of curtain-poles.

727. It is not desirable to have a curtain-pole too large in diameter, for if so it is heavy, and when long is apt to bend slightly in the middle by reason of its weight. Having selected a nice piece of red deal, from 1¾in. to 2¼in. square, plane it down

How to make them.

till it is perfectly round. The wood should be about 3in. longer at each end—that is to say, 6in. altogether—than the extreme width of the window. When the pole is finished, ends

Attachment of ends.

turned in wood, as shown at A in fig. 360, must be affixed to it. The attachment of the end to the pole is usually effected by means of a double screw, as shown in fig. 361; or a peg may be made either at the end of the pole, as shown in fig. 362, or projecting from the ornament that forms the end—the peg in the first case being thrust into a hole in the end; or, in the second, into a hole in the pole.

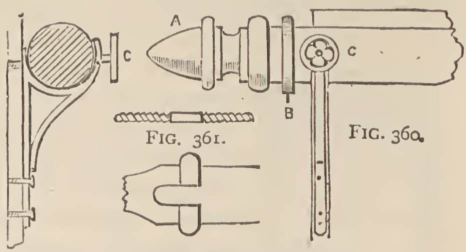


FIG. 361. FIG. 360. FIG. 363. FIG. 362.

THE CURTAIN POLE AND BRACKETS.

Brackets for carriage of pole.

Brackets, usually of brass, are then screwed to the exterior member of the moulding surrounding the window, as shown in elevation in fig. 360 and in section in fig. 363. The form of the brackets and how they are fastened to the moulding are clearly shown in the illustrations. One end is removed and the rings are put on the pole, after which the end is put on again.

The pole is then lifted on to the brackets, care being taken to put one ring, B, on either side *outside* the bracket, to keep the outer edge of each curtain in its place when they are drawn together. The pole is then prevented from being moved out of its place by means of the rose C, which is screwed through a hole in the front of the bracket, the end of the screw being forced against, and sometimes into, the pole. It need not, however, be screwed in so tightly as to do any marked damage.

Putting on rings.

Fixing pole in position.

728. Whether made of deal or beech, curtain-poles should be stained and French polished; they should not be varnished, because a varnished surface is more liable to injury from the backward and forward movement of the rings than a French-polished surface. The instructions here given apply entirely to straight curtain-poles. When curtain-poles are required for bay-windows, unless a straight pole of considerable length is used, stretching across the whole width of the bay, they must be *moulded;* that is to say, composed of three pieces, joined at an angle corresponding to the angle formed by the inclination of the side windows to the front window. This is a very nice piece of work, and unless the amateur is a skilled and practised joiner he had better leave it to the professional cabinet-maker. There is not so much difficulty, however, in making a cornice for a bay-window.

How to finish curtain-poles.

729. Cornices may be straight or moulded. When perfectly straight, as for a window in the side of a room in the ordinary way, they must be returned, that is to say, turned at each end, as shown at A in fig. 364, so as to form with the front piece, B, a sort of box.

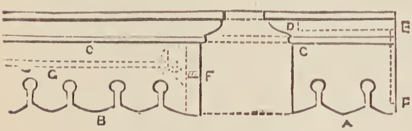


FIG. 364. THE CORNICE.

Cornices for curtains.

730. To make a straight cornice, a rectangular piece of wood is first taken, which forms the top and the means of supporting the entire fabric. To this piece of board another piece to form the front, as at B, and two others to form the sides or ends, as at A, must be attached. The ends may be dove-tailed to the front, and indeed ought to be, if neat and strong work is desired. By the aid of a centre-bit and keyhole-saw, the lower edge of the cornice may be ornamented as shown in the illustration. Round the top a moulding, C, should be nailed, and this should be neatly mitred together at the corners. To support the cornice nothing more is

How to make cornices.

necessary than to screw two iron brackets to the moulding of the window-frame, as shown by the dotted lines at D E F. The projecting arm of the bracket must, of course, be screwed to the board round which the cornice is nailed, to prevent any chance of its being accidentally dislodged. To take the curtains, two hooks, such as large, strong dresser hooks, may be screwed into the sides of the cornice, and a slender iron bar supported on them by holes in the ends. One of the hooks, and the mode of inserting it in the side of the cornice, is shown at F in fig. 364, and the bar at G.

Rail within for curtains.

731. For making a cornice to fit a bay-window, pretty much the same mode of procedure must be adopted. As the various joints used in carpentry have been fully described and explained in Part I., it will seldom be necessary for the future to do more than indicate the nature of the joint to be made. In all simple joinery of this description the ordinary dove-tail joint is all that is requisite.

Cornice for bay-window.

732. When the amateur is about to make a moulded cornice, the first thing to be done is to get an accurate model of the angles of the bay, by means of screwing three slips of wood together, and from this model the piece of board can be made that is to form the top of the cornice. It will be enough for all practical

Moulded cornice.

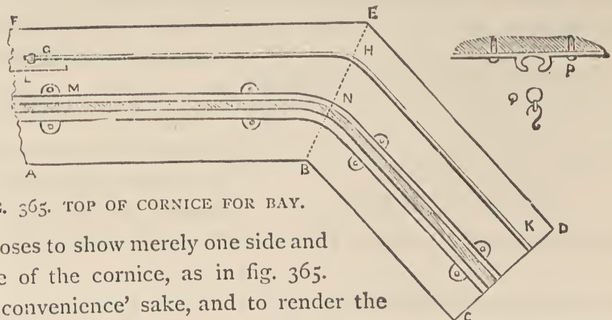


FIG. 365. TOP OF CORNICE FOR BAY.

purposes to show merely one side and angle of the cornice, as in fig. 365. For convenience' sake, and to render the whole operation more intelligible to the amateur, the figure has been drawn in accordance with the form of the window as it appears to the beholder when he stands looking at it. In reality, the surface A B C D E F that is shown represents the upper part of the board that is next to the ceiling; but it will help us very much if we take the board as transparent, allowing us to see what is underneath, rather than turn it upside down and put the piece B C D E in the opposite direction. Along the outer edges of the board A B, B C, C D, pieces of wood must be attached at right angles

to it, and jointed together at the angles B and C. The lower edge of the united boards may be ornamented after the manner of a crest board, as shown in fig. 364, and a piece of moulding nailed round the top as a finish, as shown in the same figure. The chief difficulty in the joinery will be the connection of the several pieces of wood at the angles B and C, and at the corresponding angles on the other side, which are not shown in the diagram. With these exceptions the method of making the moulded cornice is the same as that which must be followed in making the straight cornice: it is with the arrangement of the iron rods within that we have most to do here; that is to say, to show how the curtains may be drawn together, and the rings passed easily over the angle along the dotted line from B to E.

How to make it.

733. This may be done in various ways, two of which are shown in fig. 365. One of these consists of a bar of iron, G H K, with holes at G and K, which fit on to hooks screwed into the top board of the cornice. This bar sustains one curtain, and another bar, the end of which is shown at L, supports the other curtain. The rings will pass easily over the bent arc at H. The diameter of the rings used should be at least twice or three times the diameter of the bar, so that they may run easily along it from end to end. The close junction of the edges of the curtains is effected by the overlapping of the bars at G and L, which admits of the passing of the edge of one curtain over the other. Another plan is to obtain a piece of brass grooving similar to that shown in plan by M N O, and in section at P. This grooving is furnished with flanges or projecting pieces, by which it may be screwed to the top board of the cornice. A sort of button, as shown at Q, is slipped into the groove. This button will slip easily along the groove from one end to the other. About a dozen are necessary for each curtain. A shank projects from the bottom of the button, which is pierced for the reception of the curtain hook. This brass grooving may be had in one single piece, but if it is desired that the curtains should lap one over the other when drawn close, it will be better to have it in two pieces.

Arrangements for support of curtains.

Iron bars on hooks.

Brass grooving and button.

734. Curtains, whether of light or heavy materials, are drawn together more readily by cords than by the hand. A great deal of pulling and dragging is often required to bring curtains together, and this, if the curtains be closed as a regular thing every evening, tends to damage and soil them. By a very simple arrangement of cords and pulleys curtains may be drawn and withdrawn at pleasure. The cords by which this is effected

Easy mode of drawing curtains.

will hang behind one of the curtains at one side of the window, after the manner of the cords of a Venetian blind. It will be understood that this arrangement can be carried out far more easily for curtains hanging from a straight cornice than from one of the kind shown in fig. 365.

735. We must now take brackets and shelves into consideration, and consider what they are, how they may be made, and how they may be fixed. The shelf being generally of some length is mostly fixed to the wall, and constitutes what is termed a fixture. Brackets, which are short, small shelves, may also be fixed to the wall, but as they are not intended to carry or support any great weight they may be made and hung so as to be movable from place to place.

Brackets and shelves.

736. It has been said above that a bracket is a short, small shelf. Strictly speaking, however, the bracket is the piece of wood, or iron, or even stone, that is used to afford support to the shelf, which is a piece of wood, or some other material, laid upon the bracket in a horizontal position. But because the ledge on which any article is to be placed cannot be supported or fixed to the wall without the bracket, the combination of ledge and bracket has now come to be spoken of under the simple term bracket. In architecture brackets, or corbels, as they are sometimes called, are often taken advantage of to enrich the building to which they belong by ornamenting them with carving or sculptured work.

What a bracket is.

Corbels.

737. In considering any kind of constructional work—that is to say, work which consists of two or more pieces framed together, or otherwise connected—it is always useful to examine the principles on which such work is made, and to trace them to their simplest forms. Let us do this in the case of the bracket, taking the bracket, first of all, in its original acceptation as being a means of support for a superincumbent ledge.

Principles of construction of bracket.

738. The simplest form of bracket is manifestly a piece of iron bent in such a manner that the two arms of which it is formed are at right angles to each other. When bent in this way, as shown in fig. 366, the bracket is often called an angle iron, and used for affording support and strength to articles made of wood in which one piece is attached to, or supported on, another piece at right angles to it. Brackets of this description, when the arms range in length from 4in. to 6in., are often used to support narrow shelves in greenhouses, shops, etc. For this purpose they are made in the simplest and roughest form of plain iron, pierced with

Simplest form of bracket.

Angle iron.

holes for screws, so that one arm, A B, may be screwed to the wood-work, whatever it may be, at the back, and the other arm, A C, to the ledge or shelf. A better kind of bracket of this description is made of iron with a projecting rib on either side, as at X, so that the head of the screw sinks into the groove between the ribs; these are either galvanised or japanned. Now this kind of bracket being made in so cohesive a material as iron will support a considerable weight without giving way, but it is clear that the longer the arm A C is made the less will be its sustaining power. This may be best explained by supposing two brackets of this form, in one of which the arm A C is 6in. long, and in the other 12in. long. If a 56lb. weight were hung at the end of the projecting arm of each bracket, it would be found that the extent to which the longer arm would be bent downwards would be much greater in proportion than the deflection of the shorter arm.

Flanged bracket.

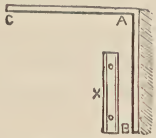


FIG. 366.
COMMON BRACKET.

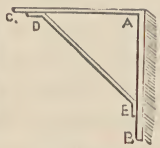


FIG. 367.
BRACKET WITH STRUT.

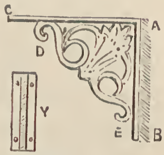


FIG. 368.
ORNAMENTAL BRACKET.

739. This being the case, means must be devised to impart rigidity or inflexibility to the bracket, and this is accomplished by attaching an iron strut to the interior of the bracket, as shown by D E in fig. 367. This strut is strongly riveted to the arms A B and A C. If a heavy weight be now suspended from the end C of the arm A C, there is no chance of the arm bending and giving way under the downward pressure, for a considerable part of the weight is transmitted down the strut D E in the direction of D E, and is received and resisted by the wall or wood-work at B, which presses outward, so to speak, against the weight to exactly the same extent as it is pressed against by the weight. A much heavier load may now be placed on A C than before the strut was attached to the bracket, for the wall now helps to support the weight, while before it was the arm A C alone that offered any resistance to the downward pressure. The next step in the formation of iron brackets or metal brackets of any kind is shown in fig. 368, in which the ornamental scroll-work D E answers the same purpose as the simple strut in fig. 367. In this kind of bracket the arms are made much wider than in the ordinary metal bracket, as shown at Y, so that holes for screws may be made in the flanges that project on either side of the ornamental work. Simple iron brackets may be bought from 1d. to 3d. or 4d. each, according

Bracket with strut.

Ornamental brackets.

22

to size. Ornamental brackets range, according to size, from 3d. to 1s. or 1s. 3d. Capital cast-iron brackets for greenhouses may be bought for 5d. or 6d. a piece. Iron brackets are now sent to this country in great quantities from America. These are slighter and more elegant in appearance than the English brackets, and are japanned and finished with greater care. Brackets of this sort in every size and shape may be obtained of Mr. Melhuish.

Cast-iron brackets.

740. Being now acquainted with the principles on which iron brackets are constructed so as to combine strength and rigidity with an ornamental appearance, we may proceed to see how far these principles enter into the construction of wooden brackets for the support of shelves, etc.

Wooden brackets.

741. Looking back on fig. 366, we can see at once that it is utterly impossible to construct a wooden bracket in this manner. The wood lacks the cohesion of the iron, or, in other words, the fibres of the wood do not lie together so closely, and hang together so tightly as the atoms or molecules of which the iron is composed. You can cut off a shaving of wood with a knife, but it takes far more trouble to detach a particle of iron from the mass of which it has formed a part, and to do this with a knife is not possible. If, however, we look at fig. 367, we see at once that a wooden bracket can be made on this principle, though not precisely in the same manner, for it will be necessary to adapt the method of connecting the pieces of which the bracket is composed to the material that we are working with. The chief points at which we have to look are these; namely, how the separate pieces can best be framed together, and how, when the bracket is made, it can be attached most securely to the wall. Now a man who knew little or nothing about carpentry would, in all probability, take a piece of wood, such as is shown from A to B in fig. 369, as an upright, and another piece, as from C to D, and a third piece with the ends cut on the bevel, as at E and F, and nail the three pieces together, putting one nail through the end D of C D, into the end A of A B, and two more through E and F, so as to nail E F to the pieces A B and C D. A very little consideration will serve to show that in such a piece of work as this there can be no strength whatever, and that to obtain a proper union of parts that shall give strength and security to the bracket, very different means must

Principles of construction.

Proper union of parts.

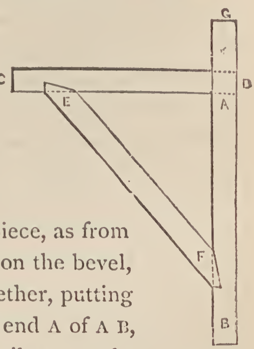


FIG. 369. WOODEN BRACKET.

be used. In the first place, a piece of wood longer than A B must be taken, such as is shown by G B. To this upright the horizontal piece C D must be connected by a tenon let into a mortise just half the width of the pieces B G, C D, which of course must be of the same width and thickness. Lastly, the ends E, F, of the strut E F must be cut, as shown in the figure, and let into notches cut for their reception, one in the upright B G, and the other in the horizontal C D. These notches need not be more than ½in. deep in the deepest part. The best way to cut a strut is first to make the notches in the upright and horizontal, and then, having connected these two pieces by the mortise and tenon joint made for this purpose, to lay them on the piece of wood intended for the strut, placed, of course, exactly in the position it is intended to occupy, and then mark off the angles at which the ends of the strut are to be cut, with a scribe or lead pencil. A wooden peg should be used to fasten the mortise and tenon joint, but the ends of the strut may be secured in their places by screws. A bracket thus made will be found strong enough to sustain any weight in reason. No attempt is made to give dimensions: as long as the principle involved in the construction of any article is made clear, it is all that is absolutely necessary. Each amateur who is making brackets on this plan can settle the dimensions according to his requirements.

How to cut strut.

Fastening mortise.

742. The next thing to be considered is how such a bracket as the one just described is to be fixed. If it is to be fixed against woodwork, three or four screws of sufficient length, passed through the upright B G—one at the top, another at the bottom, and one or two in the middle—will be sufficient; but if it is to be fixed against a brick wall, the wall must be plugged by driving pieces of wood into the wall between the bricks in the most convenient positions, to afford holding for the nails which must be driven through B G, and which would not hold in the brickwork.

Fixing strut-bracket.

743. From the bracket whose construction has just been explained the transition is easy to the bracket of ordinary shape shown in fig. 370, which is the form most commonly used for the support of shelves, wherever a single shelf is required. The dotted line A B shows the direction in which a weight placed on the shelf just above A is transmitted through the bracket to the wall or support to which the bracket is fixed. The rounded part A D C serves no useful purpose whatever: as far as the strength of the bracket is concerned, it might as well be removed as not, but if it were cut off, the appearance of the bracket would not be so pleasing to the

Ordinary bracket for shelf.

eye. The part C E F, projecting beyond the part C B of the line A B, is both useful as well as ornamental, for a screw can be better inserted at B, if the lower part of the bracket takes this shape, than if it had been triangular in form, as indicated by the dotted line A C B. Still the amateur must remember that it is only this triangular part A B G of the bracket

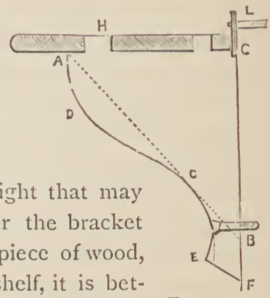


FIG. 370. ORDINARY BRACKET.

Connection of bracket and shelf.

that is instrumental in supporting the shelf, and any weight that may be placed upon it. Whether the bracket be used singly for the support of a short piece of wood, or with another for the support of a long shelf, it is better to connect it with the superincumbent shelf by mortises and tenons, as shown at G and H. When fixed to woodwork, the edge G B of the bracket and the edge of the shelf may be skew-nailed to the support behind; when fixed to a brick wall, the wall must be plugged to take the nails. If the shelf is not too large and heavy, small slips of metal may ' attached to the back of the shelf with a hole in the upper part, so that the metal may be screwed to the woodwork behind, as at L.

Plugging in walls.

744. In making brackets for attachment to garden walls to hold pots, a broad piece of wood, say 4in. in width at least, should be fixed to the back of the bracket and shelf above it, and two holes made in it by which it can be suspended on nails driven into the wall. There is no necessity for attaching the lower part of the bracket proper to the wall; it will be held against the wall by the weight of the pot and the earth it contains, and serve to transmit the pressure of the weight above to the wall, which is its chief use.

Brackets for garden walls.

745. The amateur will not expect anything to be said about making the ledges or shelves that are laid on the brackets. He will take care to cut his wood of the necessary length and breadth, and to plane up the top surface and the edges of the board in front and at the ends. If the shelf is high and the under part is visible, that should also be planed. If it be found inconvenient to connect shelf and supports by mortise and tenon, the shelf can be fastened down to the brackets by screws.

Ledges or shelves on brackets.

746. Ornamental brackets have been sufficiently treated in the chapter on fret-cutting and fret-sawing, and there will be no necessity for speaking further on the subject here. The principles involved in their construction are precisely the same, but to add to their appearance perforated work is generally added above

Ornamental brackets.

the shelf and below also; and they are often constructed, by the aid of hinges, so as to fold together. This is useful for packing and convenience of carriage.

747. The amateur may often find it desirable to fix a shelf in a recess or in the corner of a room or passage. We will give one or two examples of the method of doing this, and then proceed to explain the construction of a larger kind of shelf or bracket-table for a small hall or passage.

Shelf in recess or corner.

748. Suppose that A B C D E in fig. 371 represents the plan of a recess in a room on one side of a fire-place, A B C being the corner of the chimney breast. The first thing to be done is to determine the height of the shelf, for which 3ft. or a little more will be found convenient. Let us take the height of the top surface of the shelf to be 3ft. The shelf will be in all probability an inch thick, or very nearly so, when planed up, so that if its surface is to be 3ft. above floor level, marks must be made on the wall just 2ft. 11in. above the surface of the floor. The amateur will find that it is not always desirable to work by the flooring, because this is not always level; so as soon as the marks have been made, a straight-edge must be applied to them, and the correctness, or otherwise, of the marks tested by means of a spirit-level. When the marks have been accurately adjusted by the aid of the level, ledges, as shown at F, G, and H, must be nailed to the wall. On these ledges the shelf may be dropped, and fastened down with screws or nails. Ledges for the support of shelves of this kind should be 1in. thick and 2in. wide; the outer edges of the ledges F and H should be sloped off towards the floor, from the topmost edge; or, in other words, their corners should be cut off. Sometimes the ledges are made of two slips of wood, especially where very neat work is required; in this case the inner piece is nailed to the wall, and the outer piece screwed on to it. The heads of the screws may then be concealed with putty, or a hole may be made into which the screw may be sunk flush with the bottom, the opening being filled up with a piece of turned wood in the form of a disc or button.

How to prepare and fix shelf.

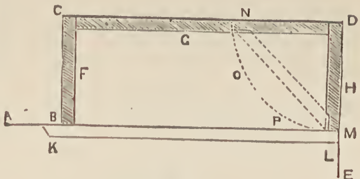


FIG. 371.
SHELF IN RECESS.

749. The shelf should be cut to fit exactly into the recess, and scribed round so as to fit closely and accurately against the wall. Fig. 372 will show what is meant by this. In this figure let A B C D repre-

sent the recess. The wall at the back having been badly plastered is irregular in form, having such an outline as is shown by the line B E F G C. Let the shelf be a little deeper than is absolutely necessary, and when all is ready for fixing, push the shelf against the back of the recess, until the straight inner edge B F C touches it where it will. Measure the breadth of the space between the shelf and the wall, where it is widest—in this case from E to K—with a pair of iron compasses. If the means of doing so are attached to the compasses, set the legs that they may not shift their position, and then, keeping the point of one leg against the wall along the line B E F G C, press the point of the other leg on the surface of the shelf. As the points of the compasses preserve their relative distance throughout, a line H K L M N, similar in every respect to B E F G C, is traced on the upper surface of the shelf, and when the corners B H K and C N M, and the hollow K L M, have been cut away with keyhole-saw or chisel, it will be found that the shelf may be pushed home to the wall, and will fit tightly against it.

Cutting shelf to fit against wall.

Operation of "scribing."

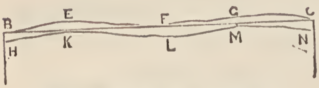


FIG. 372. SCRIBING SHELF.

750. Returning to fig. 371, the shelf must be made wider than the recess, so that the outer edge, shown by the straight line K L, may project for 1in. or 1½in. beyond the face of the chimney breast, and lap over the chimney breast A B, as shown at K. If preferred, the outer edge of the sheif may be kept level with the chimney breast, as shown by the straight line B M, and a piece of wood may then be screwed on to the edge, as shown by the space between the straight lines B M, K L, deep enough to conceal the ends of the ledges. If the shelf be brought out, in the first place, to the line K L, the ledges may be concealed by a piece of neat moulding nailed or screwed to the lower surface of the shelf, or by a slip of wood let into a groove made to receive it in the under part of the shelf.

Shelf wider than recess.

751. Brackets in the form of a quadrant or fourth part of a circle are out of place in a recess if used singly, but a pair of them may be placed in the opposite corners of the same recess, or in similar corners of two recesses—that is to say, in the corners nearest to, or farthest removed from, the chimney breast. Otherwise when used singly they can only be placed with propriety in the angle formed by two walls of a room. A bracket of this description is very useful just outside the door of a bedroom, when the door is close to an angle of the passage without the room, as a shelf whereon to rest a jug, candlestick, lamp, etc., when necessary.

Brackets in recess.

Fixing right-angled brackets.

752. The mode of putting up one of these right-angled brackets, with a circular sweep in front, is shown in fig. 371, at the right-hand corner. The ledges D M, D N, are nailed to the contiguous faces of the wall; and, if the bracket be a large one, another rail may be attached to them, as shown by the double dotted lines from N to M. Notches should be made in the ledges D M, D N, at M and N, through half their thickness, and the ends of the rail M N cut accordingly, and dropped into the notches and fastened down by skew-nailing. The triangle thus formed will afford a firm support for the shelf, which must be cut as shown by the curved dotted line O P.

Brackets handy in all parts of house.

753. It is almost impossible to have too many resting-places of this kind in the corners of rooms and the passages of a house. They are always handy for petroleum lamps, if there be no gas in the house; and if there be, they can always be made available for jars and vases and other ornaments, which will be suggested by the circumstances of position and the good taste or peculiar fancies of those who live in the house.

The bracket table or shelf.

754. The bracket-table, with a flap to move up or down at pleasure, suitable for a small hall or passage, or even as a temporary table at a window, or as an occasional sideboard in a small room, is a little more difficult to make than the fixed bracket; but the difficulties are such as may be easily overcome. We shall proceed as before to deal with the general mode and principles of construction, leaving it to each amateur who may be inclined to make one to settle its dimensions for himself. All that need be said here on this point is that 24in. or 30in. by 18in. will be found a convenient size.

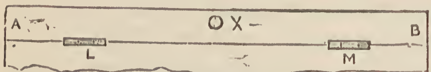


FIG. 373. PLAN OF RAIL OF BRACKET SHELF.

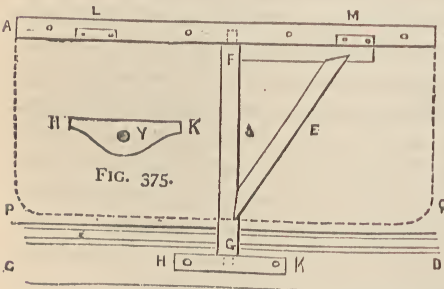


FIG. 374. ELEVATION OF RAIL AND BRACKET OF BRACKET SHELF.

Several parts of table.

755. The several parts of the bracket-shelf or table are exhibited in figs. 373 and 374. The first thing to be done is to make the flap or shelf to be attached to a rail that must be fixed to the wall, the attachment being

How to make and put them together.

made by means of hinges. The shelf should be made about 2½in. less than the width desired for the table, the entire width being made up by the rail shown in plan in the *under part* by A B in fig. 373, and in elevation in fig. 374. The rail may be from 2in. to 2½in. wide, but its width must depend very much on the thickness of the skirting-board below, shown at C D, for reasons that will be apparent presently. When all the separate parts are finished the rail must be fastened to the wall behind, and rendered immovable. Next a bracket must be made, similar in construction to that shown in fig. 369. This bracket is shown at E in fig. 374. The ends of the upright F G must be cut as shown in the form of circular pegs, projecting for about ¾ in. beyond the ends of the upright to fit into holes made—one in the rail as shown at X in fig. 373, and F in fig. 374; and the other as shown at G in fig. 374, and Y in fig. 375. Fig. 375 is the plan of a piece of wood, shown in elevation at H K in fig. 374. This piece of wood, when the pegs at the ends of F G are inserted in the holes cut to receive them, is screwed firmly to the skirting. It is plain in order to keep F G upright that the distance from the inner edge of the rail to the hole X (fig. 373) must be the same as the thickness of the skirting-board *plus* the distance of the hole Y, from the inner or straight part of the support shown at H K in fig. 375. The pegs F and G must, when all the parts are ready, be slipped into their places, and the rail and the support at the bottom screwed or fastened—the one to the wall, and the other to the skirting-board. It will then be impossible to pull the bracket E out of its place, the only motion it can have being from side to side as it turns on its pegs or pivots F and G. When the flap, which is attached to the rail by hinges, as shown at L and M in figs. 373 and 374, is let down, the bracket E folds away completely under the rail A B ; but when the flap is raised, the bracket must be pulled out until it is at right angles to the wall behind. The position of the bracket and the flap when the latter is let down are shown in fig. 374, the outline of the flap being indicated by the dotted line A P Q B. The table, flap, and fittings may be made of mahogany or of nicely grained red deal, stained as the fancy of the maker may dictate, and French polished. The edge of the flap should be neatly moulded, and the moulding should be carried on to the rail on either side for the sake of uniformity. For small houses and small rooms few things will be found more convenient than these bracket-tables.

The shelf.

The rail.

The bracket.

Rest or support for bracket.

Fixture of flap, etc.

756. Similar to these table flaps in construction and general purpose are brackets made to let down, the bracket folding back against the

wall, and the flap falling down over it. These are seldom seen in modern houses, though they frequently formed part of the equipment of old houses in the country. They afford a useful support for a lamp, a candle, a wine-glass, a tumbler, a cup and saucer, a small workbox, or any of the numerous things one may require when sitting snugly by the fire on a cold winter afternoon or evening.

Brackets to let down against wall.

757. Sometimes the mantel-shelf above was converted into a sort of tram-road on which, by the aid of a couple of cords, a couple seated one on one side, and the other on the other side, of the fire-place might pull a bottle of port backwards and forwards between them, and so pass the bottle without the trouble of moving from their chairs. In such a case, the folding bracket mentioned above formed a convenient resting-place for the wine-glass.

Passing the bottle.

758. Here our notice of shelves and brackets must be brought to an end. It will be understood that in a work of this description it is impossible to speak of everything that partakes of the nature of a shelf. For example, there is no necessity to speak particularly of an ornamental shelf covered with cloth or velvet, to be placed on a narrow or old-fashioned mantel-piece ; for with the instructions already given the amateur will be at no loss how to prepare the board, how to mould it in sweeping curves in front to suit his fancy, how to cover it with such material as may be deemed most suitable, to surround it with fringe of silk or worsted attached to the edge of the board in front and at the sides by gilt-headed nails made for the purpose, and, finally, to fix it to the wall by means of small metal plates with holes in them to admit of the passage of brass-headed nails by which they are held to the wall. The little plates are of course screwed to the back of the shelf, and the holes appear above it.

Mantel-shelf.

759. The gilt nails to which allusion is made above are sold at the ironmongers', and are also used for fastening strips of leather to the edges of bookshelves. The simplest and cheapest nails of this description are the small round-headed chair nails, which are sold at the rate of 3s. 9d. per 1,000. The larger and more ornamental nails, which are of ormolu, gilt, and washable, vary, according to size and pattern, from 1½d. to 5d. per dozen. A nail consisting of a white head, something like a conical bullet, but much smaller, attached to an iron spike, is also sold for this purpose, at the rate of 2d. per dozen.

Gilt nails for mantel-shelf.

CHAPTER VI.

TABLES, STOOLS, CHAIRS, AND COUCHES: GENERAL PRINCIPLES OF CONSTRUCTION, MAKING, AND MENDING.

Furniture Mended rather than Made by Amateur—Desirable to know Principles of Construction of Furniture—Word "Table" variously applied—Ordinary Rectangular Table—Telescope Tables—Kitchen Table: how to make it—Table height—Supports or Legs—Rails connecting Legs—Parts to be glued and pegged—The Top of the Table—How to fasten Top to Rails—Blocking Table—Meaning of "Principles of Construction"—Modifications or Extentions of Principles—Support for Round Table—How Wide Base is obtained—Construction of Round Table—Area of Support—Mobility of Desk or Top—Rim to Round Table—Catch or Latch—Gipsy Table—Construction of Gipsy Table—Parts to be well adjusted before glued—Coffee or Chess Table—Principles of Construction—How the Table is made—May be called "Bracket Table"—Modifications of Brackets for Table—Writing Table, or Occasional Table—The Supports—Slips or Ledges—Mode of Construction—Top of Table—How to Fasten it Securely—Modifications in Shape easily introduced—Construction of Chairs—The Ordinary Type of Chair—Chief parts of Structure—How to make the Back—Preparation of Front of Chair—Framework of Seat—Connection of Parts—Windsor or Kitchen Chair—Same Principles of Construction to be traced in all Chairs—Old-fashioned Arm-chair—Chair height—How to make a comfortable Arm-chair—Cutting out the Timbers—Fitting the Parts together—Seat of Chair: how formed—Stuffing of Chair—Over-all of Chintz—Mending Chairs—Sources of Injury to Light Chairs—Effects of Heat of Fire—Nails not to be used in Repairing—Fracture of Chair-rail, etc.—How to Mend it—Fracture of Rail of Seat—How to Repair it—Fractures in Windsor Chairs—Mode of Mending Fracture—Stools: why taken after Chairs—Structure of Windsor Chair and Stool similar—Principles of Construction of Three-Legged Stool—Fixing Legs—Wedging up Rails—Stools that Amateur will make—Fender Stool: its Construction—Stuffing the Top—Kneeling Stool—Ottoman or Box Stool—Construction of Ottoman—Good way of making Top or Lid—No limit to what Amateur may do—Sofa or Couch—Useful Couch for Invalids—Construction of Frame—The Panels: how to make them—Hinges to Connect Panels—Panels useful in Spine Complaint—Webbing or Iron Laths—Cushions for Couch—Conversion of Couch into Bed—Old-fashioned Sofa—Simple Bedstead—An X Bed always comfortable—Construction of X Bedstead—Connection of the Legs—Sacking and Head-piece.

760. It is not to be supposed that the amateur mechanic will often take in hand the making of a piece of furniture, such as a table, stool, chair, couch, or bed. He will, however, often be called on to try his hand at mending either one or the other during a long course of

married life, if it please God to spare him to his wife and family, and permit him to see his children's children ; and it is therefore desirable that he should know the general principles of their construction. This knowledge, moreover, is absolutely necessary to him, if he find it necessary, or to his advantage, to make a writing-table, or occasional table for house or garden, an invalid couch, or even a simple bed for a child.

Furniture mended rather than made by amateur.

761. It will be useful, therefore, to glance at the principles of construction involved in the manufacture of

1. *Tables.* 2. *Chairs.* 3. *Stools.* 4. *Couches.* 5. *Beds.*

It cannot be expected that we can enter into the construction of all the different varieties that belong to each individual heading. It is only possible to deal with such single articles as may be considered to be fair types of each group. Thus, in speaking of tables, all that can be done is to describe the method of making a square table and a round table, and to show variations from these general principles in modes of constructing writing-tables or occasional tables, gipsy-tables, and garden-tables; and to do the same as briefly but yet as clearly as possible for the other articles of furniture that have been enumerated.

Desirable to know principles of construction of furniture.

762. The word "table" is very variously applied ; there are at least thirteen or fourteen different applications of this word, as the reader may ascertain for himself on referring to any large "Dictionary of the English Language," which enters fully into and deals exhaustively with the subject. In Carpentry, however, a *table* is taken to be "a flat slab, board, or the like, having a smooth surface placed horizontally and supported by legs, which is used as an article of furniture for a variety of purposes, as to eat, work, or write upon." This is Webster's definition of the piece of furniture called a table.

Word "table" variously applied.

763. The ordinary kitchen table is a good type of the square table, and if the amateur can make a table of this description, he will be able to make any kind of square table, or, speaking more correctly, any kind of rectangular table. It will be understood that tables that can be lengthened or shortened at pleasure, such as telescope dining-tables, do not come within the compass of our plan ; their construction being too complicated, and requiring too much space and too much illustration for description here. A telescope-table must be studied in all its parts and movements before any attempt can be made to mend or make one.

Ordinary rectangular table.

Telescope-tables.

764. In making a kitchen table we have to consider, first, the supports or legs; secondly, the rails by which the legs are connected; and, thirdly, the slab or board which is laid on the frame formed by the legs and rails, and which completes the table. In fig. 376 the elevation of one side of a kitchen table is shown; and in fig. 377, the plan of the framing made by the legs and connecting rails, or rather a part of it, as it is unnecessary to give the whole, for by the aid of the diagram the amateur will be able to make a complete plan for himself according to scale. The figures here given are not drawn to scale, for reasons that have been already stated. The legs should be made out of pieces of good red deal at least 3in. square when planed up.

Kitchen table: how to make it.

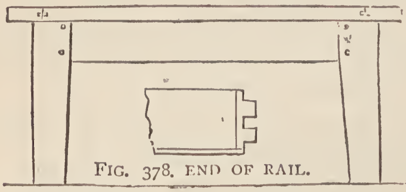


FIG. 378. END OF RAIL.

FIG. 376. ELEVATION OF KITCHEN TABLE.

FIG. 377. PLAN OF FRAMING OF KITCHEN TABLE.

Table height.

"Table height" is reckoned to be 2ft. 3in. or 2ft. 4in., reckoning from the floor to the surface of the table; the former is the more convenient height for general purposes, but as much work is done on a kitchen table in a standing posture, it is better to have a table of this kind an inch or two higher. Supposing that the slab or board which forms the top of the table is 1½in. thick, the length of the legs will be 2ft. 2½in., supposing the table to be 2ft. 4in. in height.

Supports or legs.

It will be noticed in fig. 376 that the legs are bevelled or sloped slightly on the *two* inner sides to give a lighter appearance to the table when finished. The rails may vary in depth from 4½in. to 6in., according to the length of the table; for the amateur will remember that the longer the joist or rail, the deeper it must be in order to prevent deflection under any superincumbent weight.

Rails connecting legs.

The legs are to be kept square as far as the depth of the rails, but from the bottom of the rails or a little distance below it the legs may be bevelled as drawn. The rails are cut at each end in double tenons as shown in fig. 378. These tenons fit into mortises cut in the interior faces of the tops of the legs, as shown in fig. 377, the shorter part of the tenon going only as far as the lines drawn across the tenons in the diagram, and the longer part entering the leg to the full depth. When the legs and rails have been accurately fitted to-

gether, the tenons are glued and driven home into the mortises, and secured with wooden pegs. The amateur is cautioned never to put a nail through a mortise and tenon joint, especially in making furniture, for a wooden pin can be easily bored out with a gimlet or stock-and-bit, while the extraction of a nail will tend more or less to the injury and consequent disfigurement of the wood. The value of this advice will be acknowledged when the amateur finds it necessary to put a new rail into a table.

Parts to be glued and pegged.

765. The framing being all ready, the top may be placed on it. The top must be made of boards securely jointed together by one or other of the various modes adopted for this purpose, and which have been fully described in sections 443–446, in Part I., and clamped at the ends (see section 608 and figs. 302, 303), in order to prevent warping. The top or upper surface must be planed smooth; the under part may be left rough if preferred, but the plane should be passed over the edges and the under surface where it overlaps the sides, which it should do for about 3in. The top may be fastened to the framing by means of screws; notches should be cut in the inner side of the rails and the screws driven upwards in a slanting direction as shown at A in fig. 379. This can only be done when the rail is a substantial one. In slighter tables the top is usually nailed down to the frame, but in larger tables of this kind it is useful to be able to remove the top at pleasure. Sometimes a deep groove is ploughed in the inner part of the rail, as shown at B B, and a button with a short projecting flange, as shown at C, is screwed to the under surface of the top of the table, as at D. The button turns on the screw, and the flange may be turned in or out of the groove at pleasure. There should be a button at least at every foot all round the table. When the top of any table of this kind is a fixture, it is generally "blocked;" that is to say, rectangular blocks of wood, as at E, are glued at short intervals into the angle formed by the meeting of the under surface of the top and the inner surface of the rail, to give additional strength and stability to the structure.

The top of the table.

How to fasten top to rails.

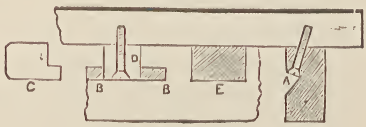


FIG. 379. FASTENING TOP OF TABLE TO RAIL.

Blocking tables.

766. The term "principles of construction" has been frequently used in these pages, and from the foregoing description of the mode of making a kitchen table, its meaning may be fairly gathered. It has been shown that the component parts of the table are the legs, the rails

at sides and ends, and the top, and it has been further shown how these various parts are to be put together. The parts and the putting of them together set forth the principles of construction. These principles enter into and govern the making of any kind of table, or support used after the manner of a table; as, for example, a washstand or dressing-table. The back of either of these, the sides connected with the back, the frame and sub-table of the washstand on which the ewer may be placed when removed from the basin, the drawers that are sometimes appended, and other additions are merely modifications or extensions of the same principles, which the amateur will be able to reduce to practice and carry out after an inspection of any article of furniture of this kind that he may wish to make or repair and a due consideration of the relation of its various parts.

Meaning of "principles of construction."

Modifications or extensions of principles.

767. A square or rectangular table is for the most part supported by four legs, one at each corner; a round or circular table and an oval table are usually supported by one leg or pillar in its centre. To each general rule there are exceptions; for example, a folding square card-table is sometimes supported on a pillar, while a round or oval table is sometimes sustained on a frame-work having three or four legs. If a disc or circular piece of wood be sustained by a central pillar only, it must of necessity be unstable and devoid of strength. In making a round table we must therefore consider what means may be used to prevent it from tipping over when a comparatively small weight or force is applied at the circumference of the disc, and to give necessary stability and firmness to the top. These means manifestly lie in the extension of the base of the support, which stands on the ground, and the superficial area of the top on which the disc is laid.

Support for round table.

How wide base is obtained.

768. All this will become clear on an inspection of the accompanying diagrams, of which fig. 380 represents the elevation of the table; fig. 381 the arrangement by which stability and support is given to the top; and fig. 382 the means by which the foot or base of the table is extended to prevent it from being easily turned over. Suppose that in fig. 380 the only two members of the table were the top A B and the pillar C D, it is manifest that the only part at which the top can touch its support is the small circle at the top of the pillar at C, shown in plan in fig. 381 at C, and the extent to which the pillar rests on the ground is the slightly larger circle at the bottom of the pillar at D, also shown in plan at D in fig. 382. It is equally clear that a very little pressure at A or B, or any other point of

Construction of round table.

the circumference, would upset the table. The area of support to the circular disc A B is extended from the small circle

Area of support.

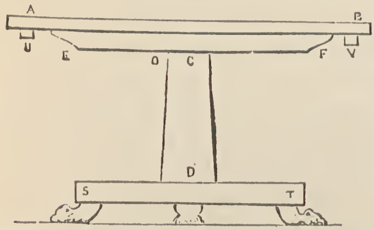


FIG. 380. ELEVATION OF ROUND TABLE.

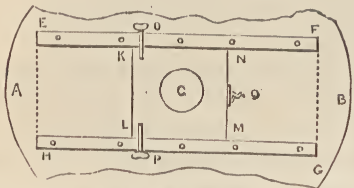


FIG. 381. UNDER PART OF TOP IN PLAN.

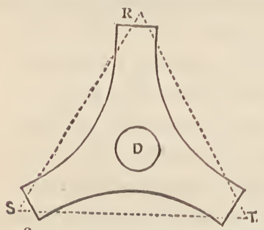


FIG. 382. FOOT OR BASE IN PLAN.

C to the parallelogram E F G H, by keying the top of the pillar C into a square block of wood of tolerable thickness, shown by K L M N in fig. 381, and attaching arms or stout slips of wood E F, G H, to the sides K N, L M, of the square piece of wood. Screws are then put through these slips to fasten down the top of the table to them. This is the mode pursued when the top of the table is fixed immovably to the pillar and its adjuncts, but sometimes it is convenient that the disc may be turned from a horizontal to a vertical position. The slips E F, G H, are then attached to the top of the table only, and not to the sides, and thumb-screws are passed through holes in the slips, as shown at O and P, and enter blocks of metal let into the square piece of wood at two opposite and contiguous corners. The blocks are in reality fixed nuts, as they are pierced with female-screw cuts in which the thread of the thumb-screw works. The top of the table turns on these thumb-screws as on pivots, and is held in place by a catch at Q. A table of this kind is not so firm and stable as one whose top is immovably fixed. Looking at fig. 382, we see that the area of support on which the table stands is increased from the circle D to the triangle R S T, which renders the table tolerably firm and less apt to be overturned. It does not, however, for obvious reasons, offer the security that a square base would give. As it is only necessary that the base of support should touch the ground at its extreme points, each corner is generally supported or raised above the ground on a turned knob, or a piece of wood carved in imitation of a lion's foot, hence a round table is generally described as having

Mobility of disc or top.

"pillars and claws." The end D of the pillar is keyed into the base R S T, in the same manner that C is keyed into the square block K L M N. Instead of being strictly triangular in form, the piece that forms the base is usually curved out in the manner represented in the drawing (fig. 382). In the better kind of tables, a rim, as shown at U and V in fig. 380, is fastened to the under side of the disc; partly to give an appearance of solidity and massiveness to the top, and partly to hide from view the slips E F, G H. In the catch Q, in fig. 381, the catch or latch is pressed outward, and kept out to the fullest extent by a spring. When the table is in a horizontal position the bolt is caught and held by a plate in K L M N, and the top is thus retained in its place until the latch is drawn back by the hand.

Rim to round table.

Catch or latch.

769. As gipsy-tables are always round, and the most useful form of garden table is a circular disc, it will be as well to look at the methods by which these may be made before considering how to make a rectangular writing or occasional table. Of these the gipsy-table, as it is called, possibly because it is supported on a tripod, resembling in some measure that on which gipsies sling a kettle in order to boil water, presents the greatest difficulties in its construction. Still these tables are fashionable; and the amateur by taking a little trouble may easily add one to his stock of furniture.

Gipsy-table.

770. The elevation of a gipsy-table is represented in fig. 383. A B is a flat circular disc forming the top of the table. This top, when the table is finished, is usually covered with cloth or velvet, and surrounded by fringe to match, nailed to the edge with gilt-headed nails. The means of support is a double tripod, consisting of three rails above and three rails below, projecting from a ball or globe of wood. The ball and rails are usually turned, and the rails are more ornamental than shown in the diagram, being generally formed so as to look like a number of small balls strung on a wire, as it were. In turning the ball, the ring or zone at top and bottom, at which the legs or rails enter the ball, should be indicated as an aid in boring the holes to receive the rails. These holes should be bored in a straight line from the surface of the ball towards the centre. In doing this with accuracy, and in cutting the rails to the proper bevel at the ends,

Construction of gipsy-table.

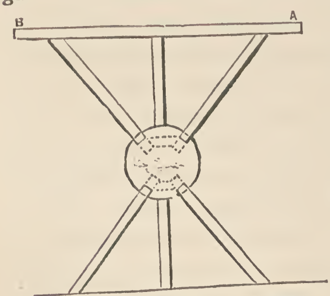


FIG. 383. ELEVATION OF GIPSY-TABLE.

so that the table-top may rest upon the upper rails, and the lower rails on the ground in a proper manner, lie the chief difficulties in making a gipsy-table. The amateur should not attempt to glue the rails into the ball until the parts are properly adjusted one to the other. The upper set of rails are screwed to the top of the table by screws put through them in a slanting direction.

Parts to be well adjusted before glued.

771. A table that will serve equally well as a coffee-table or chess-table within doors, and a garden table out of doors, may be made by a very simple contrivance. The writer has never seen any tables of this description, but it by no means follows that there are not many in existence made on the same plan. It is a modification of the system on which small three-legged pillar tables used to be made half a century ago; the shaft being comparatively short, and the legs issuing from the bottom of the shaft, and descending in a curved sweep to the ground. In the adaptation of this mode of making a table, strength is gained by making the shaft or central pillar longer, and giving the legs a greater length of attachment to the shaft. The supports for the table-top are similarly made.

Coffee or chess table.

Principles of construction.

772. In this kind of table A is a circular pillar or shaft shown in elevation in fig. 384, and in plan in fig. 385, which, as the shaft is of the same diameter throughout, will serve as the plan of the top as well as of the bottom. Deep grooves are cut in the shaft at top and bottom, at B, C, and D, to receive the brackets E, F, G, which may be glued and skew-nailed to the shaft. The brackets may be pierced, as in the manner shown in fig. 384; but the perforations, while they tend to give lightness to the general appearance of the brackets, must not be made so large as to detract from their strength. The top must be laid on the upper set of brackets, and attached to them by screws from above and below, as shown in fig. 384. By a little management, and giving a slanting direction to some of the screws, they may all be put in from below, thus

How the table is made.

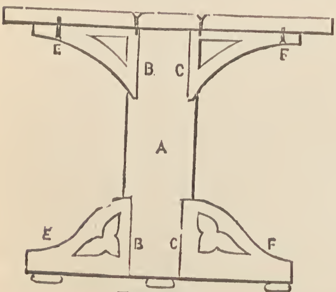


FIG. 384.
BRACKET TABLE (ELEVATION).

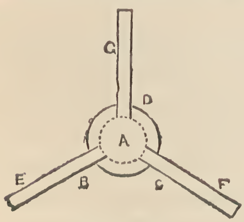


FIG. 385.
BRACKET TABLE (PLAN).

preventing any injury to the surface of the table. The shaft of the table for out-door purposes should be about 4in. in diameter, and the brackets should be of $1\frac{1}{4}$in. stuff planed down, which will reduce its thickness. For in-door purposes a lighter shaft and thinner stuff may be used, and the shaft may be ornamented in the lathe to give additional lightness to it. When finished the table should be stained and varnished or French-polished. The brackets that form the legs may be supported on turned knobs. As brackets are so freely used in its construction this table may be appropriately called the "bracket-table."

May be called "bracket-table."

773. For the sake of imparting some degree of variety to tables made in this manner, the grooves, made at each end of the shaft for the reception of the brackets, may be continued throughout its whole length, and each pair of brackets, one at the top and the other at the bottom, be cut out of one and the same piece of wood, and be made symmetrical. In this case the wood connecting the brackets should project the whole way beyond the surface of the shaft, forming a raised rib, as it were, between the projecting parts. The ingenuity of the amateur will suggest many modes of treating the brackets and intervening ribs so as to render them highly ornamental.

Modification of brackets for table.

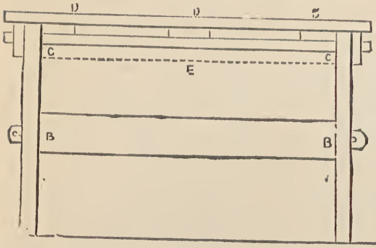
774. A simple method of making a writing-table or occasional table is that of supporting the table-top at each end on legs crossed in the form of the letter X, after the manner of the stand that is used to support a butler's tray, but constructed so as to be rigid instead of movable. Writing-tables and library-tables are generally narrower in proportion to their length than ordinary tables supported on four legs; they have, however, when the legs are crossed, this inconvenience, that it is not possible for persons to sit at the ends, but as they are seldom used by more than one person the inconvenience is materially lessened indeed, and reduced to a matter of the least importance.

Writing-table or occasional table.

775. In this kind of table, as in all others, we have to consider the supports, the frame, and the top; but here, however, the frame is not so conspicuous a member of the structure as in the square table, and holds a more subordinate position. In fig. 386 the end elevation of the X table is shown; the front or side elevation being presented in fig. 387. To make the saltire-shaped supports, four pieces of good straight-grained red deal must be selected, two for each end, each piece being about 3ft. long and 6in. wide. This will leave room for cutting the boards in some such manner as is shown in fig.

The supports.

386 so as to give an ornamental appearance to the legs. As the pieces are to be framed together by halving them into one another at the



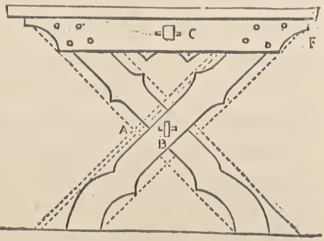


FIG. 387. WRITING TABLE (FRONT ELEVATION). FIG. 386. WRITING TABLE (END ELEVATION).

part marked A where they cross, the wood used for the legs should not be less than 1in. in thickness when planed down; and if 1½in. stuff be used it will add greatly to the stability of the table. Across the upper part of the cross formed by the legs, a slip or ledge of wood F ¾in. thick must be screwed; this is the only part that answers to the framing of the square table, and serves to support the ends. The mode of construction is sufficiently shown by fig. 386, and will need no further explanation. When the cross-pieces have been halved together and the ledges securely screwed on, the supports for the ends of the table-board or top are complete, and it now only remains to consider how they may be connected, which is shown clearly in fig. 387.

Slips or ledges.

Mode of construction.

776. The top of the table must be formed in the usual way of ¾in. boards glued up together, and held in clamps till dry, or connected by tongue and grooves as already explained (see Part I. sections 308, 443). To give strength to the table-top, ledges should be screwed across the boards on the under surface, as shown at D, D, D. The supports for the ends must now be connected by a rail B B, whose ends are cut into the form of a tenon, and passed through the part of the support where the cross-pieces are halved together. A hole is made in each projection, and through the hole a wooden pin is given, locking the supports in an upright position against the shoulders of the rail at either end. To afford a better support to the table-top, and additional strength to the supports, another narrower rail C C is passed through the ledges and secured in a similar way by pins inside and out. This rail should be placed in such a position that the ledges may bear tightly upon it. Even greater firmness and stability may be given to the table by making the rail C C as deep as the ledges D, D, D, that is to say, as deep as the dotted line E, and notching it at the top to receive

Top of table.

these ledges, which may be concealed by a slip of wood about in. in depth screwed to the under part of the table on each side. These slips should be just of the depth of the shoulder F in fig. 386, and this shoulder should not be less than 1 in. The table-top should be screwed down securely to the broad edges at either end. When this is done the whole structure will be found to be as secure and rigid as any table made in the ordinary way. It will be understood that there is no necessity whatever to make the rails B B, C C, perfectly plain as shown in the illustration; they may be shaped to suit the fancy of the maker, after the manner of the legs of the table in fig. 386. An infinite variety of forms will suggest themselves, but care should be taken to let the pieces of wood, out of which rails and legs are made, be deep enough to admit of being cut into without impairing the stability of the table. The dotted lines in fig. 386 show the width of the pieces of wood used for the legs before the indentations have been made.

How to fasten it securely.

Modifications in shape easily introduced.

777. Let us now consider the principles of construction of chairs in the same manner as we have considered how tables are made, so as to present the greatest degree of firmness and stability. In doing this, it will be useful to see, first, how a common wooden chair may be made. This will show the general method on which chairs are made, there being, of course, certain modifications in different kinds of chairs which cannot be described in a work of this kind. Afterwards we can pass on to a review of the most common fractures and injuries that happen to cane-bottomed chairs and Windsor chairs, which are chiefly used in ordinary houses, and see how they may be best and most easily repaired.

Construction of chairs.

778. It may be objected that the chair shown in the accompanying

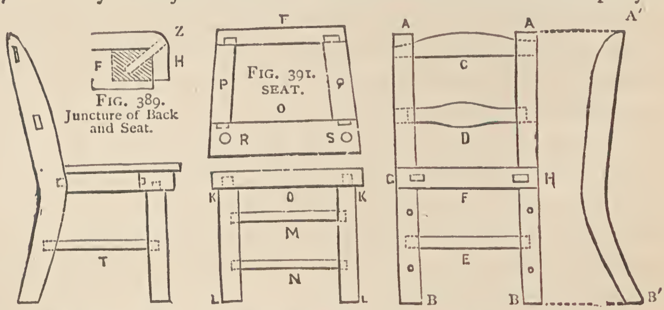


FIG. 392. SIDE. FIG. 390. FRONT. FIG. 388. BACK.

DIAGRAMS OF PARTS OF CHAIR, SHOWING PRINCIPLES OF CONSTRUCTION.

illustration is a very ordinary wooden chair of ugly appearance. It is so, assuredly, but as the matter now before us is how a chair is

generally made, and not its beauty from an artistic point of view, the plainness of the illustrations may be pardoned. It is sought here to give merely a typical chair, in order to exhibit as clearly as possible the general principles that enter into the construction of most chairs. When the amateur has mastered these by the aid of the diagrams and the inspection of any ordinary chair, he will be all the better able to repair his chairs when broken, and to make any structure to serve the purpose of a chair.

The ordinary type of chair.

779. In a chair, the chief pieces are those parts of the structure which form the back, front, and seat. The legs in front and behind are connected by two or more rails, which serve as the sides. Lastly, the framework of the seat must be furnished with a board or bottom of some kind, in order to complete the chair.

Chief parts of structure.

780. Let us take the back first, as shown in fig. 388. The first thing to be done is to cut out two pieces of wood, as shown in the figure at A B, A′ B′, the front elevation of these pieces being shown at A B, and the side elevation at A′ B′. It will be noticed from the side elevation that the legs of the chair are cut so as to project outwards behind beyond the area covered by the seat; the legs in front, especially in cane-bottomed chairs, are cut to project in the same manner. This is done in order to make the base of the chair as wide as possible, and so to render it less liable to be turned over. The back is completed by connecting these pieces of wood with three rails—two broad and flat, to afford support to the back, as shown at C and D, and one round, as shown at E. Two notches are cut at G and H to receive the rail F, which forms the back part of the seat. To help the amateur to comprehend the structure of the chair completely, the back part of the seat is shown as a rail, inserted in the back in the notches cut for its reception. The manner in which the rail F is joined to the back is shown more clearly in fig. 389. The shaded part shows the extent to which the rail F enters the leg H. It is secured in position by driving in a peg, sometimes put in angle-wise, as at Z.

How to make the back.

781. We must now pass on to the front, which consists of two legs, K L, K L, attached to each other by the rails M, N. The rail O is the front of the framing of the seat, and is introduced here to show the connection between the front legs and the seat. The framework of the seat itself is shown in fig. 391. In this we have in plan, at F and O, the back and front of the frame, as shown in elevation at F in fig. 388, and O in fig. 390. It will be noticed that the front of the

Preparation of front of chair.

Framework of seat.

chair is always broader in front than behind, in order to accommodate the extension of the legs which always takes place when one rests on a chair in an easy sitting posture. The front and back of the seat-frame are connected by short rails, P and Q, attached by horizontal tenons of no great length, that enter mortises cut in front and back in order to receive them.

782. The back, front, and seat being now ready, holes must be made in the under part of the front rail in order to receive the upper ends of the front legs, which are cut in the form of pegs to enter the holes, as shown in fig. 390. Two rails are also made, as shown at T in fig. 392, in order to connect each front leg with the corresponding leg behind, and to give additional stiffness to the chair. The front and back, it must be understood, have already been securely glued and clamped, and all that now remains to be done is to glue the notches at G, H, in the back, and the pegs at K, K, in the front, and the ends of the rails T—two of these rails being wanted, one for each side—and then to drop the seat into its notches, and over the pegs of the front legs, and the rails (T in fig. 392) into their places, and bring the whole firmly and closely together by the aid of clamps. Lastly, the seat may be made by boarding over the seat-frame, or by inserting strips of cane interlaced, to give support one to another, and forming a strong but elastic net-work.

Connection of parts.

783. In the wooden chair, known as the Windsor or kitchen chair, the construction differs slightly, inasmuch as no framing is required for the seat, which consists of a solid piece of wood slightly hollowed out, in order to render the seat more comfortable for the sitter. The legs are inserted in holes bored for their reception in the under part of the seat, and the back, which is formed in a variety of ways, is dropped into mortise holes cut in the seat to take the ends of those pieces which form the uprights of the back. No illustration of the Windsor chair is necessary here. An examination of one will fully explain its construction. It is, to describe it roughly, nothing more than a flat piece of wood almost square in shape, raised on legs and furnished with a back. It is, in fact, little more than a simple stool with a back attached to it.

Windsor or kitchen chair.

784. As in the case of the legs of the X table, however varied the ornamentation or form of the pieces of which the chair is composed, the principles of construction will remain much the same throughout. Thus in the ordinary cane-bottomed chair the front of the seat is rounded in shape, approaching very closely to the arc of a circle, while the side rails that

Some principles of construction to be traced in all chairs.

connect it with the back-piece of the seat are slightly serpentine in form. This is merely a modification of outline, the general principles of construction are in no way altered or departed from.

785. The most comfortable kind of chair that can be devised is the old-fashioned arm-chair, with a seat of webbing, sustaining a thick and comfortable cushion, and padded sides, and arms and back. Any amateur who can use his tools tolerably well may make a chair of this kind, and furnish himself with a comfortable retreat and resting-place on cold and wet winter evenings, and in times of fatigue or sickness. It will be worth while to describe the general structure of a chair of this kind.

Old-fashioned arm-chair.

786. Before proceeding further it may be as well to remind the reader that there is a "chair height" as well as a "table height," which governs the height of all ordinary chairs above the ground. When the height of a chair is spoken of, the height of the surface of the seat above the ground level or floor is meant. Table height, it was said, varies from 27in. to 29in., 27in. being the ordinary height, while 29in. is an extreme height, and one that is not often used. Chair height for an ordinary chair is 17in., the height being measured from the ground to the upper surface of the front rail of the seat. Easy chairs and lounging chairs are slightly lower, music chairs higher. The seats of ordinary chairs are level; but those of easy chairs are generally lower behind than in front to admit of a slightly reclining position for any one who may occupy the chair.

Chair height.

787. Fig. 393 will furnish the amateur with a good idea of the side elevation and general construction of a really comfortable arm-chair—a veritable easy chair that will afford rest and promote repose. A chair of this kind may sometimes be picked up at a furniture sale, and cleaned, re-stuffed, and repaired; but failing this the amateur may make one for himself without much difficulty. It is better to make the frame out of a harder kind of wood than deal. Beech is the best wood, but if beech cannot be procured, and if, when obtained, the amateur finds it somewhat difficult to work, good red deal can be used instead. The first thing to be done is to cut out the timbers that form the hind legs and the sides or

How to make a comfortable arm-chair.

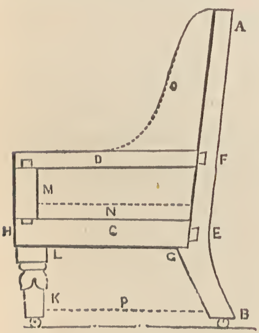


FIG. 393.
OLD-FASHIONED ARM-CHAIR.

chief supports of the back, as A B in fig. 393. It will be noticed that the part above the seat is not so thick as that below the seat. This affords opportunity for making a projection G, which carries one end of the rail C. This rail is mortised to the back upright at E. The tenon may be carried through the upright or not, according to fancy. The joint will be stronger if it be carried right through. The rail C should be made a little thicker in front at H than behind at E, in order to give a due slant or fall to the seat, by causing the upper surface of the rail to slope gently from front to rear. The lower surface is perfectly horizontal, so that the front leg K may be perpendicular. This leg may be plain or ornamental. It is usually turned and screwed into the block L, which in its turn is attached by screws to the bottom of the rail C at H. The rail D is mortised into A B at F; this rail is of the same thickness throughout, and should be perfectly level. A short upright, M, serves to connect the bottom rail C and the top rail D, and affords a support for the latter. The sides of the chair are connected by cross-pieces of timber at H and E, and similar rails connect the uprights of the back at A and a little above F, completing the framework. The actual seat of the chair is a movable cushion of some thickness, but the support for the cushion is obtained by webbing nailed in the direction of the width of the chair and parallel to the front and back rails of the seat, interlaced with webbing in a direction parallel to the rail C, and nailed, one end to the front rail and the other to the back rail, connecting the sides. The webbing thus nailed on affords a strong and tolerably elastic support for the cushion, which is indicated in section by the dotted line N. The arms and back are generally well padded inside, canvas being nailed neatly over the outside of the chair, over each side, and over the back. To keep the padding in its place, the sides and back may be sewn with a ong packing needle, the string that is used being passed through patches of leather, circular in form, to keep the string from cutting through the canvas or hessian with which the framework of the chair is covered, as shown in fig. 394. It will be understood that the skeleton only of the chair is shown in fig. 393; the stuffing or padding is not shown. Additional comfort may be gained by attaching a side-piece to the chair, as at O, as a support to the head when asleep in the chair. Chairs of this kind are generally covered with an overall of pretty chintz or cretonne.

Cutting out the timbers.

Fitting the parts together.

Seat of chair, how formed.

Stuffing of chair.

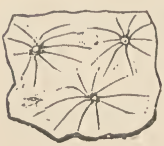


FIG. 394.
PADDING OF CHAIR.

When the legs of the chair are plain this covering may be allowed to descend as far as the dotted line P, but when the front legs are turned it need not come lower than the under surface of the rail C. Legs of this description for arm-chairs or couches may be bought at the turners' or upholsterers' ready made, if the amateur is not possessed of a lathe in which he may turn them for himself.

Overall of chintz.

788. It depends very much upon the kind of fracture that a chair has received whether or not it can ever be rendered serviceable again, and it may be useful here to consider one or two of the injuries by breakage to which cane-bottomed chairs and Windsor chairs are most subject. The amateur will seldom be called on to repair other kinds of chairs, and if it happen that the broken chair is a valuable article of furniture, the best thing he can do is to send it to the cabinet-maker, who will repair the damage so as to be all but imperceptible and send it home again looking, to use a common phrase, "as good as new."

Mending chairs.

789. Cane-bottomed chairs and Windsor chairs are not the strongest structures in the world, and by "ricketting" them about, or moving about on them as young folks often will, so as to bring the chairs on two legs instead of four, they often get unduly strained, and the legs and rails are loosened. Another fruitful source of injury to a Windsor chair, used in the kitchen, is turning it into a temporary horse before the fire for drying anything that may be wet. The heat of the fire dries the wood and causes it to shrink, and as a natural consequence those portions of the chair which are glued together get loose. In such cases, the best thing to be done is to glue up the loose parts afresh, and hold them in place with clamps until the glue is hard and dry. Never attempt to put a nail through the seat into the top of the leg, or through the leg into the end of the rail that connects it with the opposite leg. These chairs are generally made of beech or elm, and nails will not readily enter these woods. Indeed, both beech and elm, when the wood is not very thick, are liable to split when a nail is driven into the end of a rail, etc., on account of the closeness and crookedness of the grain. On the contrary, nails may be driven into deal with impunity in most cases, for the wood is soft, and the straight grain yields readily in all directions to afford a passage for the nail. When it is said that a Windsor chair is made of elm, it must be noted that it is the seat only that is of this wood, the back and legs being generally made of beech, or some hard wood resembling beech in its general character.

Sources of injury to light chairs.

Effects of heat of fire.

Nails not to be used in repairing.

790. If the rail of a chair breaks, whatever may be the shape of the fracture, it is useless to try to mend it. The best thing to be done, in every case of this kind, is to make a new rail. The old rail, it is true, may be fished and spliced, but the remedy will be pretty nearly as bad as the disease, and even this mode of repairing a fracture is impracticable when the line of breakage is close to the leg. When through a fall or any blow, the leg of a chair gets broken, as legs will break sometimes, when the grain runs in a slanting direction across the leg instead of up and down its length, it is well-nigh impossible to mend the fracture in a creditable manner. All that can be done—unless a new leg is put in, which is out of the question, because part of the leg is turned in the lathe—is to resort to fishing and splicing, or to glue up the broken part and wrap a piece of canvas or stout calico smeared with glue around it to keep the parts in place. After a few days the wrapping may be torn away. If the joint has been neatly made and the glue is good, the chair may last for some time longer, but it is by no means to be depended on, and should be used as little as possible.

Fracture of chair rail, etc.

How to mend it.

791. Referring to fig. 391, the framing of the seat of a chair, it often happens that the side-pieces, P and Q, will sometimes break across close to the tenon by which the piece is attached to the hind rail. Suppose A in fig. 395 to represent such a fracture. There is manifestly no way of uniting the broken pieces by nails, screws, or pegs; as no nail, screw, or peg would hold the fracture together. All that can be done to render the chair serviceable for a while longer is to notch out a piece of wood as at B, so that the ends may come against and be flush with the outside of each hind leg, and then to screw it up, as shown by the screw at E, to the piece that forms the hind part of the frame of the seat C, which is notched into the leg D. The piece of wood B, extending from side to side of the chair, affords a support not only to the broken side-piece, but to the sound one as well, and the chair is rendered nearly as strong as before. Instead of a piece of wood, means of support for the broken side-piece may be obtained by screwing an angle-iron into the angle formed by the side-piece and the leg as at F. For this purpose excellent angle-irons, in the best malleable iron japanned, are supplied by Mr. Melhuish in various sizes, from 2in. to 5in., at prices ranging from 1s. 6d. to 3s. per dozen. These angle-irons are strengthened by being made much thicker at the bend than the ordinary angle-iron,

Fracture of rail of seat.

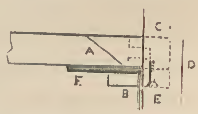


FIG. 395. FRACTURE IN FRAME OF SEAT OF CHAIR.

How to repair it.

and the larger ones consequently make admirable brackets for supporting shelves. Brass brackets of the same kind, strengthened at the angle, may also be obtained—1½in. brackets being 1s. 8d. per dozen; 2in. brackets, 2s. 6d. per dozen, and larger sizes in proportion. On account of their great strength and superior finish, amateurs will find these useful for connecting and strengthening the parts of various structures in wood as well as for mending chairs and supporting shelves.

792. The practice of attempting to repair any damage done to a chair by nailing the broken or disconnected parts together is much to be reprehended. Driving in nails will only, in nine cases out of ten, make the damage worse than it was before. If the end, or rather corner, of the seat of a cane-bottomed chair gets loosened from the leg into which it is notched, the course generally adopted by the amateur is to drive a nail or two through the leg into the rails of the frame of the seat. The proper thing to be done is to bore a hole through the leg into the frame with a small auger-shaped bit, and after gluing the corner of the frame, to make a peg a trifle larger than the hole so that it may fit tightly, and after dipping the end of it in glue, to drive it into the hole. This is shown at Z in fig. 389, but instead of a single peg, two may be used, one through the back and the other through the side of the leg, their respective directions being at right angles to each other. This will effectually prevent any further withdrawal of the frame from the notch in the leg. A common line of fracture in the elm seat of a Windsor chair is shown in fig. 396. Elm is gnarled, crooked-grained stuff, and it has happened that by undue pressure on the leg, perhaps by the rails that hold the leg to those opposite to it in the front and behind, that a piece of the seat has been broken off along the line A B. To attempt to nail it on is useless. It must be held in its place by a clamp, and the holes bored through the broken part and into the seat with an auger bit as at D, E, F, in the directions shown by the dotted lines. The broken piece must then be glued and fastened to the other part of the seat with pegs dipped in glue, the whole being held in a clamp until the glue is perfectly dry and hard. The leg may then be inserted once again into the hole after the end has been glued, and the rails also glued and clamped till dry. The circle marked on the top of the seat is intended merely to show the direction that the leg takes,

Fractures in Windsor chairs.

Mode of mending fracture.

FIG. 396. FRACTURE IN SEAT OF WINDSOR CHAIRS.

and that the line of fracture is on the interior of the hole into which the leg is fitted. It is impossible to describe any and every kind of damage that may happen through breakage, but what has been already said will prove generally useful to amateurs in the matter of mending broken chairs.

Stools, why taken after chairs.

793. It has been thought better to take stools after chairs instead of before them, although in reality the stool may be considered to be the parent, so to speak, of the chair. What, indeed, is the Windsor chair, but a board supported on four legs after the manner of a stool, which has sometimes three and sometimes four legs, the back having clearly been an after-thought?

Structure of Windsor chair and stool similar.

794. The structure of the lower part of the Windsor chair, or the Windsor chair without the back, is identical in almost every respect with the stool; but as the legs of the stool—taking the stool on which a dairy-maid sits when milking a cow—are short, there is less need to connect them with cross-rails. Thus it may be laid down as a rule that in all stools of this form, when the height is not more than 12in., the legs need not be connected by cross-rails; but when the stool is above 12in. in height, and especially when above chair height, as in the case of a music stool, the structure should be strengthened by cross-rails.

Principles of construction of three-legged stool.

795. The reason of this will be apparent from fig. 397, in which the principles of construction of a three-legged stool are shown. These principles are identical with those on which a four-legged stool is made, so that a single illustration will serve for both. If the legs are short, as in the milking stool, they will be stiffer and less liable to be driven outwards, provided they are properly fixed in the seat, when a heavy weight, as of the human body, is deposited on the top of the seat. Thus, if the legs of the stool are cut off at A, B, and C, as shown in the diagram, there will be no need of connecting them; but if they be longer, as in a music stool, it will be safer to have rails; for the longer the legs the weaker will be the structure, the tendency to drive outwards under an equal weight being much greater.

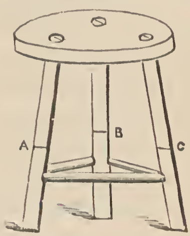


FIG. 397.
THREE-LEGGED STOOL.

Fixing legs.

In fixing the legs in a stool of this kind, either as a temporary garden seat or a stand for a plant, the holes for the legs should be bored clean through the board that forms the seat with a stock-and-bit, the ends of the legs should then be sawn across to the depth of 1in. or 1½in., and when they have been

driven into the holes as far as they will go, wedges of hard wood should be inserted in the saw-cuts and hammered in as far as possible. Anything that projects beyond the level of the seat must then be neatly sawn off. Whenever the end of a rail or projecting piece of wood is fixed into another piece, *going right through it*, whatever may be the form of the end, it should be wedged up in this way. It is to impress this necessary mode of imparting additional security and firmness to work of this kind, that "wedging-up" has been dwelt on here to an extent that might otherwise appear needless.

Wedging up rails.

796. The stools that the amateur will be chiefly called on to make for use within doors will be fender stools, and ottoman or box stools. These come more within the province of the cabinet-maker and upholsterer than that of the ordinary carpenter and joiner; but it will be useful for the amateur to know how to make them, in order to mount any piece of work, in the form of either Berlin-wool work, or braided cloth or velvet, that may have been executed for this purpose.

Stools that amateur will make.

797. A fender stool may be of the box or ottoman form, that is to say, constructed with top, sides, and ends of wood; but it is sufficient to have a piece of board only for the top, with three or four supports beneath it that will bring the top of the stool just level with the top of the front of the fender. In making such a stool solid supports are far better than legs. There should, of course, be a support at each end; it will depend entirely on the length of the stool whether there should be one more support in the centre of the board that forms the top, or two having the same distance between them as there is between each of these and the end support next to it. That is to say, if the stool be 4ft. 6in. long, and the supports be 1½in. thick, and the ends of the stool overhang the supports for 1½in., the clear distance between each support, there being four of them, will be one-third of 4ft. 6in. less 9in., or one-third of 3ft. 9in., which is 1ft. 3in. In the fender stool, the ends and centre pieces used as supports should be mortised into the board that forms the top of the stool. It will add to the general appearance of the stool if the *outer edges* of all the supports and the *outer faces* of the

Fender stool: its construction.

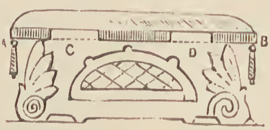


FIG. 398. END SUPPORTS OF FENDER STOOL.

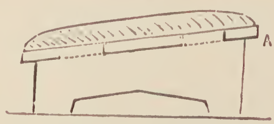


FIG. 399. KNEELING STOOL.

end supports be carved as indicated in fig. 398, which shows the outer face of an end support, and how it should be mortised, as at C, D, into the board A B. A piece of strong canvas or hessian should be tacked to the edges of the board A B, one end being left open, the canvas being a little wider than the board, to admit of the introduction of the stuffing, which may be clean cotton flock. This must be pressed into place along the whole length of the stool, proceeding from the closed end to the open end. To do this properly a long stick must be used, broader at one end, after the fashion of a ramrod. The further corners must be filled first, and the stuffing then proceeded with regularly and evenly until the nearer corners are reached; these must be closely packed with flock, and the canvas or hessian drawn tightly over them and nailed to the edge. The work must then be strained over this foundation, and finished round the edge with a handsome bullion fringe tacked on with gilt-headed nails.

Stuffing the top.

798. In fig. 399 a stool of convenient shape for kneeling when praying in church, or when reading family prayers, is indicated. It consists of a flat board, longer or shorter, according as it is intended to run the whole length of the pew, or for one person only, raised on two or more supports of the form shown in the figure. The top may be stuffed as in the fender stool above described, a piece of felt carpeting being strained over the canvas instead of work, or even a piece of green or scarlet baize. When the stool is used as a support for the feet as well as for kneeling, any chance of soiling the dress or trousers of the kneeler may be prevented by nailing a flap of baize or carpeting to the back of the stool along the edge A, large enough to cover the whole of the top of the stool when pulled forward over it. This should be thrown back when the feet are placed on the stool. The woodwork of this and the fender stool should be stained and varnished. The kneeling stool may be finished with fringe or gimp round the edge. A strip of leather, as wide as the board that forms the top is thick, contrasting in colour to the material with which the stool is covered, looks very well when nailed round the edge of the board with gilt-headed nails. Carpeting of a sober pattern should be used for kneeling stools in a church; a blue, green, or scarlet ground, with a fleur-de-lys, or cross, or small diapered pattern in black or some contrasting colour, is most appropriate.

Kneeling stool.

799. In figure 400 the construction of an ottoman or box stool is shown. These stools are generally square in form, and are usually upholstered with a handsome piece of Berlin-wool work. They may, however, if intended for use rather than orna-

Ottoman, or box stool.

ment, be covered with carpeting to match the carpet of the room for which they are intended. If the sides of the box are covered as well as the top, the best finish is a piece of heavy silk cord round the top and bottom of the sides of the box, and at the corners, a tassel to match being attached at each of the upper corners. In the diagram the sides are supposed to be of wood, stained, if of deal, and French-polished.

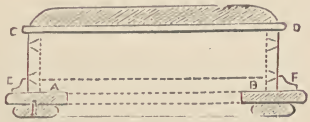


FIG. 400. OTTOMAN OR BOX STOOL.

Construction of ottoman.

The construction is simple enough. Four pieces of wood that form the sides are dove-tailed together in just the same manner as the sides of a box. These pieces are about 3in. wide and from 12in. to 15in. long. The top is boarded over flush with the frame ; but a broad ledge, as at A B, is nailed round the bottom, leaving the interior of the stool open. The breadth of this ledge serves all the better for attaching the balls or bosses that form the feet of the stool, which are put on with screws. The work is strained over the top, which is stuffed in the manner already described. If the work covers the top only, and not the sides, it is desirable to cover the edge with a rounded moulding, as shown at C D. Another moulding of different form is placed in the angle formed by the sides of the frame, and the ledge below, as shown at E and F. This does away with the abrupt and ugly appearance that the angle would otherwise present if left unfilled.

Good way of making top or lid.

A good plan for making ottomans of this kind is to strain the cloth or material that forms the top, whatever it may be, on a separate piece of wood or frame of the same size as the top of the box, or just so much less than the thickness of the work when nailed on, which will bring it to exactly the same size. The moulding C D should be raised slightly above the upper edge of the frame, or rather top of the box, that the board with the work attached to it may be dropped into the recess. When made in this way the piece of wood on which the work is strained must be screwed down to the top of the box with a few screws driven in upwards from the inside.

No limit to what amateur may do.

800. It will be at once manifest to the amateur that it is impossible within the limits of this work to touch on every kind of article that may be comprised within the general and comprehensive term, "household furniture." If he can use his tools well enough to make a small and strong kitchen-table, and thoroughly understands the principles of its construction, he can make, as we have said, any kind of table or article that acts as a table, in

furnishing a stand or support for anything, as, for example, a wash-stand, so that there will be no necessity to say anything about furniture of this kind here. Cupboards, chests of drawers, etc., and their component parts, such as door and drawers, must be dealt with hereafter.

Sofa or couch.

801. The amateur, in all probability, will never seek to make a sofa or couch—at least such a sofa or couch as is sold nowadays with suites of furniture in mahogany or walnut, for dining-rooms and drawing-rooms. If he has purchased an old sofa or couch and seeks to repair it, he can gather how to do it, when he has looked into its construction, from that which has been already said on the general principles of carpentry and joinery. As a rule, however, the men who are obliged to help themselves are comparatively poor, and unable to give those that are nearest and dearest to them all they require in the form of a comfortable couch. We will therefore endeavour to describe a couch that an amateur may contrive to make, and which may prove of great comfort and service to an invalid wife or child who for some cause or another has to pass many hours in a recumbent posture.

802. The couch to which allusion has been made is shown in end

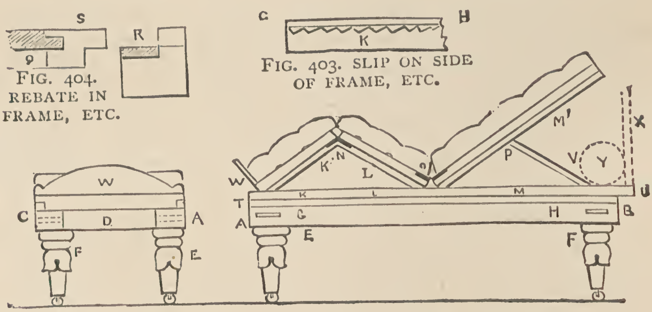


FIG. 404. REBATE IN FRAME, ETC.

FIG. 403. SLIP ON SIDE OF FRAME, ETC.

FIG. 401. END ELEVATION. FIG. 402. SIDE ELEVATION.

USEFUL INVALID COUCH.

Useful couch for invalids.

Construction of frame.

elevation in fig. 401, and in side elevation in fig. 402. The first thing to be done is to make a strong frame 6ft. long and 2ft. 6in. wide. For this purpose two pieces, 6ft. long, about 2in. or 2½in. thick, and 3in. wide, should be selected; and two more 2ft. 6in. long, and the same in width and thickness all of sound, red deal. The longer rails are shown in A B in fig. 402. the shorter ones in A C in fig. 401. The shorter rails, when all have been planed up, must be mortised into the ends of the longer rails as shown at D in fig. 401, so as to form a strong, solid, and substantial

frame. Square blocks as at E and F must be screwed to the frame, pierced with female-screws into which the ends of the legs are screwed. These legs, supposing the block to be 2in. thick, may be 12in. long exclusive of the castor attached to the lower end of each leg; they may be bought ready made of the turner or upholsterer; or if the amateur has a lathe he can turn them for himself, or get them turned by any one in his immediate neighbourhood who executes work of this description. A long slip G H just 1in. square, or a little less, is nailed along the outside edge of the sides of the frame, and in the framing itself for the distance of about 12in. from each end, as shown at K in fig. 403, notches are cut in order to form a kind of rack for a purpose that will appear presently. This completes the frame of the couch. The length of the side rails, as shown in A B in fig. 402, has been taken above at 6ft. This is long enough for children and women of average height; but when the couch is required for a tall woman, or for a man, it will be better to make the side rails 6ft. 6in., or even 6ft. 9in. long. This kind of couch is especially useful in spinal complaints.

The panels: how to make them.

803. The next thing to be done is to make three panels, two 18in. in length, and one about 3ft. 3in. long (or a little longer if the side rails be more than 6ft. in length), all of them being 2ft. 6in. wide at the top, but 2ft. 4in. at the bottom, so as to fit into the rebate made in the sides of the frame as at R in fig. 404, by nailing on the slips to the sides of the frame as previously described. The dark shaded part in R shows the notching in the frame as mentioned above. To fit the rebate thus formed the sides of the framing of the panels must be made as at S, the panel being shown at Q. The framing and the top of the panel will thus be flush throughout, and the ledges in the outer part of the framing will fit over the slips on the sides of the frame of the couch. When the panels are lying flat on the frame they will be in the position shown by T U, in fig. 402, the short panels being indicated by K and L, and the longer panels by M. The short panel K does not project beyond the end A of the frame, but the long panel M, being 3in. longer than half the length of the frame, projects to the same distance beyond it over the end B. The panels must now be connected by hinges, those which connect the panels K and L being screwed on below, while those which connect the panels L and M are screwed on above; so that the panels K and L may be raised upwards in the form of the letter V reversed, thus Λ, while the panel M may be lifted so as to form a V with the panel L. In the upper part of fig. 402 the panels are shown lifted into this posi-

Hinges to connect panels.

tion as at K′, L′, M′, the hinges connecting the panels, and the relative positions that they occupy, being shown at N and O. The bottom of the framing of the panel K′ is kept in position by the rack at the end A of the frame of the couch; the panel M is kept in the inclined position, as shown at M′, by a frame V, which is hinged to the back of the panel at P. Thick cushions of cotton flock, rather longer than the panels, are made to suit each; and to sustain the cushion on the panel K in position when raised into the zig-zag form shown at K′, L′, M′ in fig. 402, a ledge is fixed across the bottom of the panel, as shown at W in this figure, and fig. 401. By making the cushions a little longer than the panels, no gap is visible between them when the panels are raised in the manner shown at K′, L′, M′. The comfort to be derived from a couch of this description is very great. The panels when made of wood are better calculated for complaints of the spine when the patient is obliged to lie for some hours every day perfectly flat on the back. The construction of the couch is such as will admit of the patient lying at full length, as when the panels are flat, as shown at K, L, M, or in a more comfortable position with the legs bent slightly, and the back raised when the panels are as shown at K′, L′, M′. If there is no absolute necessity for having wooden panels, sacking or webbing may be stretched over the frames, or iron laths, similar to those used for iron beds, may be interlaced and screwed down to the framing with screws whose heads are round above and flat below so as to grip the lath and hold it tightly to the wood. When the frame is nicely stained and varnished, and the cushions covered with a pretty chintz or cretonne, the whole makes by no means an ugly piece of furniture, and if it appear to be somewhat stiff and formal in appearance, these defects are amply atoned for by its comfort and utility.

Panels useful in spinal complaints.

Webbing or iron laths.

Cushions for couch.

804. When the panels are laid perfectly flat so that their surfaces form one dead level from end to end, a head board may be fixed across the upper end, as shown by the dotted lines at X, and a pillow for the head placed against the head-board as indicated by the dotted circle at Y. The method to be adopted for fixing the head-board will be described in section 809.

Conversion of couch into bed.

805. If the amateur can make a couch of this description, he will not find much difficulty in making an old-fashioned sofa with upright ends and back, or a couch with one end and a back about two-thirds of the length of the couch. Both sofa and couch may be made with a frame as shown above, to which the ends and back must be attached; or, in the case of the sofa, ends may be made

Old-fashioned sofa.

something like the back of the easy chair shown in fig. 393, these ends being connected with rails to form seat and back. For the couch only one raised end will be needed. The form that either will assume when completed must be left to the requirements and taste of the amateur; it is only with the general principles of construction that we are here concerned.

806. It is not to be supposed that the amateur carpenter will ever seek to make for himself an elaborate four-post bedstead, or even a wooden French or Arabian bedstead; but if he be an emigrant in one of our colonies, he may find it useful to be able to make simple bedsteads for general use; and if he be a comparatively poor man at home, he may find it equally answer his purpose to make a bedstead for a servant or a child, or even foı a spare bed which may be put up anywhere in a few minutes as occasion may require.

Simple bedstead.

807. The bed about to be described is one that from the form and arrangement of its legs is called an X bedstead. It is impossible to find any kind of bedstead, however elaborate it may be and however well fitted with springs, that affords a more comfortable resting-place. The writer, as a boarder in the Grammar School at Plymouth, close to St. Andrew's or the "Old Church," but now devoted to other purposes, slept for years in a bed of this kind, in a large room which was supposed to have been the refectory of the monks who once were said to have tenanted the building; and he remembers with gratitude the many comfortable nights' rest he has had in it, and the pleasure, not unmixed with apprehension of coming evil, he has experienced from the so-called steeplechases, which were generally held on Sunday mornings, round the room from bed to bed, and which unfortunately ended more than once in broken legs, the sufferers from this calamity being the bedsteads, and not those that tenanted them.

An X bed always comfortable.

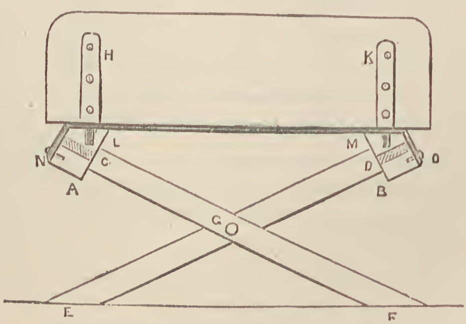


FIG. 405. SIMPLE FOLDING BEDSTEAD.

808 To return, however, to our subject, namely, how to make an X

bedstead. The first thing to be done is to get two pieces of deal, about 3in. wide and about 2½in. thick, to form the sides of the bed.

Construction of X bedstead.

One angle of each of these pieces must be planed off all along its length, so as to bring it in section to the shape shown at A and B in fig. 405, which represents the head of the bed as seen from behind. Other pieces of stuff—hard wood will be found better than deal—about 2in. wide and 1½in. thick, or even a little stouter, must be taken for the legs, which will have to be mortised into the rails that form the sides, as shown at C and D. These legs must be cut at an angle, as shown at E and F, so that they may stand flat on the floor when the bed is opened out. Care must be taken to cut the mortises in the rails in such a manner that the legs attached to one rail may come against those in the other rail. This may be better explained by aid of fig. 406, in which, supposing that A and B are the surfaces of the rails in which the mortise holes are to be cut, if the mortise holes in A are made in the positions indicated at C and D, the mortise holes in B must be made in the positions indicated by E and F, so that both the legs inserted at E and F may be passed between the legs inserted at C and D, the outsides of the former pair being in close contact with the insides of the latter; or the mortise holes in B may be made in the positions indicated by E and G, so that the legs inserted at E and G may pass both on the right side of the legs with which they are respectively brought in contact. It is precisely on this principle that the stand for a butler's tray is made; the chief points of difference between a butler's tray-stand and an X bedstead being, that the legs of the former are longer than those of the latter, while the rails on which the tray rests are shorter; that each pair of legs of the butler's tray-stand is connected near the bottom by transverse rails to strengthen them, while those of the bedstead are not; and, lastly, that the sacking from rail to rail in the bedstead is replaced by three pieces of narrow but strong webbing in the tray-stand. Most amateur carpenters will have a tray-stand of this kind, and an examination of it before beginning to make the X bedstead will greatly assist them in the work they are about to enter on.

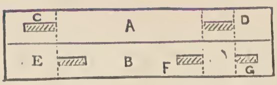


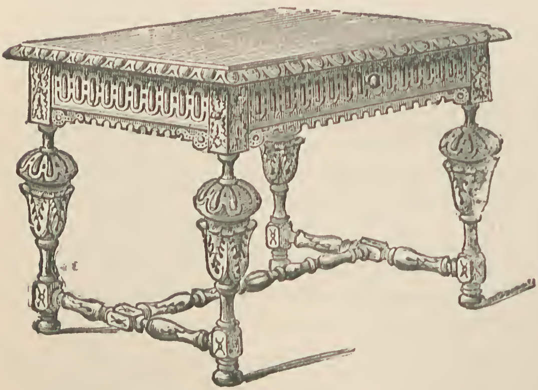
FIG. 406. DISPOSITION OF LEGS IN FOLDING BEDSTEAD.

809. The legs are fastened together at the point where each pair cross one another by a bolt and nut, as shown at G in fig. 405. The head of the bolt is shown in the illustration; the nut, which should always be inwards, being on the other side of the legs, and therefore hidden from view. A piece of strong sacking is

Connection of the legs.

then nailed across the bedstead, from rail to rail; it should extend from the corner N to the corner O. The sack-cloth will prevent the legs from opening beyond a certain extent, and, when the bed is opened for use, affords a comfortable and tolerably elastic support for the mattress and any one who may occupy the bed. The head is formed by a piece of board, as shown in the illustration, with pieces of wood or iron screwed to the back, as at H and K, with pins at the bottom which fit into holes, L and M, bored through the sacking and into the side rails for their reception. The head is put on after the bed is opened to its fullest extent, and prevents the bed from collapsing or shutting up, as it might do, under the pressure of any weight that might be placed on the sacking if there were no contrivance of this kind to keep the sides extended and the legs tolerably rigid.

Sacking and head-piece.



CHAPTER VII.

WINDOWS, DOORS, AND GATES.

Windows – Why treated separately — Classification of Windows — Casement Windows—Cross-bars not Essential—Definition of Casement Window—Simple Casement Window and Frame—How to Make the Frame—The Frame for the Glass—Connection of Frame and Window—Knob and Fastener—Stops: where to place them—Hingeing at top or bottom of Frame—Rack and Stay Hook—Principle and Construction of Rack—Stay Hook · how it is fixed—Rack with Knuckle-joint—How to attach Rack—Stops on Window-frame—Description given applicable to all Windows of this kind—Casements suitable for Framed Houses—Construction of Double Casements—Casing and Stops—Suitable finish for Casement—Sash Windows—Machine-made Sash-bars—Making of Sash-frame difficult—Closure of Upper and Lower Sash-frames—Amateur should know how Sash-frame is made—Construction of Sash-frame—Weights balancing Frame—Breakage of Sash-line—Mending broken Sash-line—Description of interior of Frame—How to take out Sash—The Pocket in Frame: how to find it—Weight to be taken out—How to get in new Cord—Knotting Cord to Weight—Nailing Cord to Frame—Replacement of Sash, Bead, etc.—Windows and Doors: how defined—Classification of Doors—Ledge Doors: their appearance—Frame for Ledge Doors—How to make a Ledge Door—How to fix the Door—T Hinges or Cross-garnets—Latch and Fittings for Door—Framed Doors—Why Framed Doors are used—Parts of a Framed Door—Rails, Styles, and Panels—Construction of separate parts of Door—Grooves for Panels—Moulding in Panels—Position of Stops—Butt Hinges—Hanging Door a difficult operation—Fixing the Hinges—Sinking Hinges in Work—Styles and Rails for Cupboard Doors—Construction of Simple Cupboard Door—Temporary Door for Hanging Closet—Conclusion of Remarks on Doors—Gates of different kinds—Ordinary Field Gate—Posts or Supports—Construction of Gate—The Strut and its use—Light but strong Gate—Fasteners for Gates—Simple method of making small Gate—Gate at top of Flight of Stairs—Garden Gates—Good Gate for Garden—Construction of Gate.

810. As windows form an essential, though a separate and distinct, part of house-building, as far as it may be practised by the amateur in the construction of sheds, greenhouses, etc., and as doors also, whether for cupboards or any small enclosed space, or as the means of entrance to rooms or outbuildings of any kind, are also pieces of carpentry that are complete in themselves, a short chapter may be devoted here to their consideration. It is all the more necessary and convenient to take windows and doors separately, because it is impossible to treat of the construc-

Windows.

Why treated separately.

tion of a cupboard or wardrobe without mentioning the door which is so essential a part of each; and, when the structure of various kinds of doors have been described, a mere allusion to them is all that will be necessary when speaking of those various structures, and articles of furniture of which they form a part.

811. Windows may be broadly classified as being of two kinds—casement windows and sash windows. Casement windows are hung on hinges like doors, or made to move on pivots inserted in the centre of the sides of the window-frame. Sash windows, on the contrary, slide up and down, being raised and lowered and retained in any desired position—whether slightly open or opened to the utmost extent—by counterbalances in the form of iron weights attached to the window-frame by means of sash cords that work over pulleys set in the frame in which the sashes work.

Classification of windows.

812. For outbuildings of all sorts, whether sheds or constructions used as workshops, greenhouses, or summerhouses, casement windows will be found most convenient and most suitable to the purposes of the amateur. From the description of one casement window and the method of hanging it, the amateur will easily see how all windows of this formation, whether large or small, may be made and hung. In all kinds of windows, as glass is now so cheap, the amateur is counselled to make them without cross-bars, resorting to them only when the window is of great size, and even then restricting himself, if possible, to vertical bars, which will reduce the size of the panes sufficiently for all purposes and positions with which the amateur may have to deal.

Casement windows.

Cross-bars not essential.

813. A casement window may be defined as a movable frame, fastened by hinges to and within another frame fixed in position. In brickwork this fixed frame is placed in position, and the bricks built up around and over it; but when the structure is made entirely of wood, advantage may be taken of the vertical timbers of which the framework of the building is made to hang the casements to these, and so save the cost and trouble of making a special frame to receive them.

Definition of casement window.

814. Let us, first, take the case of a simple casement window and frame inserted in a brick wall. The elevation of a window of this kind is shown in fig. 407, and the transverse section in fig. 408. Of course here, as in other descriptions of articles to be made by the amateur carpenter, dimensions are altogether neglected, for these are relative and subordinate to the position and extent of opening to be filled by the window, and must be determined

Simple casement window and frame.

accordingly. It will be sufficient to say that in most cases timber 3in. wide and from 2in. to 3in. long will be sufficient for the frame, and from 1½in. square to 2in. by 1½in. or 2in. square for the frame in which the glass is to be inserted. The dimensions having been settled, and a working drawing having been made, the amateur may proceed to the construction of the window and the frame that encloses it.

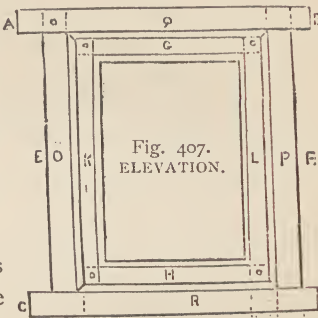


Fig. 407. ELEVATION.

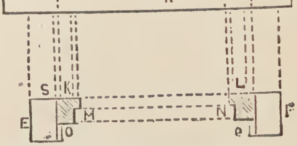


FIG. 408. TRANSVERSE SECTION. CASEMENT WINDOW.

815. The first thing to be done is to cut off the requisite lengths—the horizontal pieces A B and C D, and the vertical pieces E and F, and then mortise E and F into A B and C D, leaving the ends A, B, and C, D, of the horizontal pieces projecting beyond the outside surfaces of E and F. This is done for two reasons, first, to give greater strength to the mortise and tenon joints, which would be weakened if the projecting pieces were cut off flush with the outside surfaces of E and F; and, secondly, to enable the frame to be fixed with greater security in the brickwork; the projections entering into the brickwork and being held above and below, if not on all sides, by the bricks somewhat after the manner of a mortise and tenon joint. When the uprights have been mortised into the horizontal pieces and secured by pins, the frame is complete, and ready to be put in its place.

How to make the frame.

816. The frame for the glass is made in much the same manner, but a rebate must be cut in the pieces of which the frame is composed for the reception of the glass. In the case of the inner frame the horizontal pieces are mortised into the uprights instead of the uprights being mortised into the horizontal pieces, as in the outer or fixed frame. Thus in fig. 407 the horizontal pieces G and H are mortised into the uprights K and L, and firmly pinned together. The lines within G, H, K, L denote the rebate, which is shown more clearly at M and N in the section in fig. 408. In small windows of this kind no cross-bars or even vertical bars are required; if, however, the window be of some size and the chances of breakage from stones, etc., be above the average, as it will be in some cases, it may be desirable to reduce the size of the panes by vertical bars or even cross-bars. The

The frame for the glass.

Connection of frame and window.

window-frame having been primed and glazed, it will be necessary to fix it in position. We will assume at first that the window is to open inwards. In this case the inner frame must be inserted in the outer frame, and the extent marked round the inner surface of the outer frame with a pencil. Stops, as shown at O, P, Q, R in fig. 407, and in section at O and P in fig. 408, must then be nailed round the inner surface of the outer frame, the inside of the stop in every case just touching the pencil mark. The window must then be attached to the frame by a pair of hinges, 2½in. or 3in. common iron butts being the most suitable, as shown at S in fig. 408. A knob is usually attached to the inside of the window, being inserted in the side opposite to that to which the hinges are screwed, for the purpose of pulling the window open. The window is fastened and kept from being forced inwards by wind or any other pressure by an iron or brass button, screwed to the fixed frame so as to be turned over or away from the window at pleasure.

Knob and fastener.

Stops: where to place them.

817. It will be at once apparent to the amateur that if he wishes the window to open outwards the stops must be put inside instead of out, and the window brought flush with the *outside* of the fixed frame instead of the inside. The hinges will also be turned outside instead of inside. In fact, the window and window-frame are precisely the same as described above, only that what was the inside of the window in the first case is the outside of the window in the second case. When the window opens outward, the button which is screwed on inside must be fixed to the window instead of the frame, and be turned at pleasure over or away from the stops.

Hingeing at top or bottom of frame.

818. It may be convenient for some reason or another to hinge the window to the top or bottom of the frame instead of either of the sides. In this case the mode of procedure is precisely the same; but when the hinges are attached to the bottom of the frame, it is necessary to prevent the window from opening beyond a certain extent by means of a small piece of iron or brass chain attached at one end to the frame, and at the other end to the window, by small staples. If the hinges are attached to the top of the window and top-rail of the frame, the window must be kept open by means of a rack or stay-hook. The rack is shown in fig. 409, and the simple stay-hook in fig. 410.

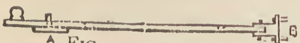


FIG. 409. RACK.

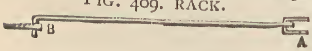


FIG. 410. STAY HOOK.

Rack and stay hook.

819. The rack is an iron bar pierced with holes that fit over a peg A, which is screwed to the frame, the rack itself being screwed to the window at B, a piece of iron to which the perforated bar is attached by a pin, on which it moves to right or left as may be necessary. The stay-hook, on the contrary, is fixed to the frame by a staple, as shown at A, and the hooked end drops into an eye B, which is screwed into the frame. The rack costs from 8d. to 1s., according to size; the stay-hook from 3d. to 6d. There is another kind of rack, consisting of two arms moving on a pivot, by which they are jointed together in the middle and fastened at the other end by pins to plates which are screwed, one to the window and the other to the frame. Some of these racks are fitted in the centre with a grooved joint, technically called a "knuckle joint." Thus the raised part of one arm is pressed into the grooved part of the other arm by means of a thumb-screw, and the extent of opening may be regulated at pleasure, the arms being fixed in position by the action of the thumb-screw. These racks are more suitable for attachment to the *sides* of windows when hinged at top or bottom. They should never be attached to the part of the frame that is *opposite* to the hinges; for, as this moves in an arc of a circle, it is manifest that the two-armed rack will not act properly unless placed at the side. For windows that are hinged at the top and open outwards, the stay-hook or the bar-rack figured above are the most suitable. For greenhouse windows an arc of iron is often used, pierced with holes at intervals. This arc moves within a piece of iron whose sides are also pierced with holes, and when the window has been opened to the desired extent, a pin is thrust through the holes to prevent further motion outwards or inwards.

Principle and construction of rack.

Stay-hook: how it is fixed.

Rack with knuckle joint.

How to attach rack.

820. While speaking of greenhouse windows, it may be useful to say that, instead of putting stops round the inside of the frame to prevent them from being pushed inwards, the same result may be attained by nailing a slip of wood about 1in. in breadth all round the window on the outside, projecting about ⅜in. beyond it. When the window is closed this acts as a stop to keep it from further progress inwards; it also tends to prevent the ingress of rain between the window and the frame, which often causes the wood to swell and renders it difficult to open the window.

Stops on window-frame.

821. The preceding description of the casement window and the method of hanging it by hinges to its frame holds good, as far as

the making and fixing of the window itself is concerned, to a window attached to the framing of a wooden building as well as to one fastened to a frame built into brickwork. All that is necessary here is to see what provision should be made for finishing a window such as we have been considering, when the framing of the building is adapted to furnish the frame of the window.

Description given applicable to all windows of this kind.

822. This kind of window will be found particularly useful by those who are building weather-boarded houses or framed houses covered with Lascelles' Patent Concrete Slabs. Let us suppose that A, B, and C are three uprights or vertical timbers mortised below into the horizontal timber that lays after the manner of a sill on the concrete footing, and at the upper ends into D, a timber on which the roof is sustained, if the structure be what is called a lean-to. It has been determined to have a double window, that is to say, two windows, one on either side of the upright B, hinged, the one on the right to A, and the one on the left to C. Having determined the position and the length of the window and the thickness of the sill, it will be necessary to notch two pieces of wood, as E and F, into the uprights above and two more, G and H, into the uprights below. The lower timbers G and H form a bed for the sill, and suitable means of attachment for the boards or slabs, as the case may be, that are put up immediately under the window-sill. When these transverse pieces have been fixed in their places, the next step is to put on the sill K, which should be notched into the uprights at each end and in the centre, and sloped slightly on the upper and outer ledge, so that no rain may effect a lodgment on it, but may trickle off to the outer edge. When this has been nailed securely in its place, two rectangular openings are formed, round which a casing should be nailed, as shown at L, M, N, and O, in each opening. This casing may vary from $\frac{5}{8}$in. to 1in. in thickness, and should project beyond the outer face of the uprights and other parts of the frame-work sufficiently to allow the

Casements suitable for framed houses.

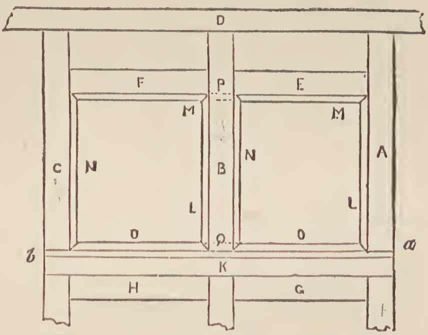


FIG. 411. CASEMENT WINDOWS IN FRAMED HOUSE.

Construction of double casements.

weather-boarding or slabs, as the case may be, with which the framework is covered in to drop within them to the extent of at least ½in.

Casing and stops. There is no absolute necessity to continue the casing at the bottom, as at O, but it makes a neater and more symmetrical piece of work when this is done. The casing takes the place of the frame in which the window is placed when set in brickwork, and to this the stops must be nailed and the windows hung. There is no necessity to show the windows in the drawing, or even the stops, for the windows themselves are made and fixed in a similar way to that shown in fig. 407. A piece of wood must be dropped between the casings and nailed to B to give a proper finish to the window, and take away from the depth between the casings H and L on either side of it; and it will look all the better if two pieces of wood are nailed on, one at P and the other at Q, as if the casing were continued along the whole length of the double window. It is practicable to use the uprights and horizontal pieces as the frame of the window without the intervention of any casing; but in this case that which is now considered to be casing in fig. 411—namely, L, M, N, O, in each window—will be stops, and narrow pieces of wood must be nailed to the uprights A, B, and C, and the cross-pieces E and F, to serve as projections, within which the ends of the weather-boards or the slabs may be dropped. Of course these projecting pieces must be nailed on flush with the inner edges of the openings.

823. Referring back to fig. 407, in which is represented a window in a frame set in brickwork, or a concrete wall, a finish may be given to the frame and window by nailing a neat moulding round the frame, both on its inner and outer surface, close in each case to the outer edge of the frame.

Suitable finish for casement.

824. With regard to sash-windows, it is unlikely that the amateur will ever attempt to make a window, having the sash divided into many and small compartments as was usual in the latter part of the last and the early part of the present century, until the duty on glass was taken off—and glass being consequently much cheaper, the fracture of a pane is not a matter of so much moment as it was years ago. Indeed, except in fancy work for greenhouses and conservatories, sash mouldings are now but seldom used. In most cases the sash at top and bottom consists of a frame in which one large pane is set, or at the utmost the space is divided into two parts by one vertical bar, or into four parts by a vertical bar and a horizontal bar crossing each other at right angles.

Sash windows.

825. When a frame of this kind is made, sash-bars moulded to the

desired form by machinery are used. The making of the frame is easy enough as far as construction goes, but difficult on the other hand, inasmuch as the whole work throughout its various component pieces requires to be very neatly and accurately framed together. The transverse pieces at top and bottom must be mortised into the upright pieces or the sides; the upright bars in their turn must be mortised into the transverse pieces of the frame, and the cross-bars must in their turn be mortised into the sides and vertical bars. When every part is ready, the pieces must be glued up, and put together with a few strokes of the mallet, the tenons being tightly fastened into the mortise holes by wedges. The bottom rail of the lower sash is made from two to three times as broad as the upper rail. The bottom rail of the upper sash, instead of being planed flush with the rest of the frame, is made in a sloping direction inside, the width of the lower part being the greatest. In the same manner the outer part of the upper rail of the lower sash is made to slant outwards and upwards, so that the upper part of the rail is the thickest. This will be clear from fig. 412, in which a section of the upper rail of the lower sash is represented in A, and a section of the lower rail of the upper sash in B. The grooves in which the sashes respectively work are shown at C and D, E being the parting-bead between the two sashes, F the inner beading which confines the inner and lower sash, and G that portion of the sash-frame that confines the upper and outer sash.

Machine-made sash-bars.

Making of sash-frame difficult.

Closure of upper and lower sash-frames.

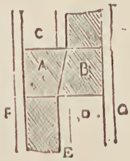


FIG. 412.
JUNCTION OF SASH-FRAMES.

826. It is far more useful for the amateur to understand the construction of the sash-frame than that of the sash itself, for he may be called on, now and then, to repair a broken sash-line, and, unless he is aware how the sash-frame is made, he will find this no easy task: indeed, it is very doubtful if he will be able to do it at all. The construction being known, the mode of going to work in order to substitute a new and strong sash-line for the broken one is easy enough.

Amateur should know how sash-frame is made.

827. The frame into which the sashes are fitted is a somewhat complicated arrangement, or at least it will appear so to the amateur. Between the solid sill at the bottom of the window, which rests on the stone ledge or sill, and the thick piece of wood which forms the lintel across the top of the window, two box-shaped sides are fixed, to which are attached the beads or guides which keep the sashes in their places, and in which are inserted the

Construction of sash-frame.

pulleys over which run the cords to which the weights are attached, which are concealed out of view in the boxes. In fig. 413 this arrangement is explained; J is the lintel at the top of the sash-window, and K the sill at the bottom; H and I are perpendicular pieces of wood that form the fronts of the boxes that are fixed on each side of the window, the sides that are next the observer, who is supposed to be within the room, being cut away, except near the bottom of the window, so as to show the weights. These weights, W, W, work over the pulleys, P, P, that are inserted transversely in the fronts, H and I, of the side boxes. The weights that meet the view in the illustration are those attached to the bottom sash, which is closed. When the weights are near the top of the frame, the sash, as it has just been said, is closed, consequently when the sash is raised the weights will descend, keeping the sash in any position to which it may be lifted, allowing it to be raised until the top-rail is nearly in contact with the lintel. When through length of time the sash-line is worn and breaks, the weight falls with a crash to the bottom of the frame, and the window is rendered incapable of being worked with ease, and to a certain extent dangerous; for if the other cord break, as it will do sometimes if it is attempted to work the window with only one cord and weight, the sash will fall with considerable weight and force, breaking some of the glass by the concussion, if the glass be thin and the panes many as in old-fashioned windows, and perhaps inflicting a severe bruise, and breaking the skin of the back of each hand of the person who is raising the window, and who, being unprepared for its sudden fall, has not had time or presence of mind to pull them out of harm's way.

Weights balancing frame.

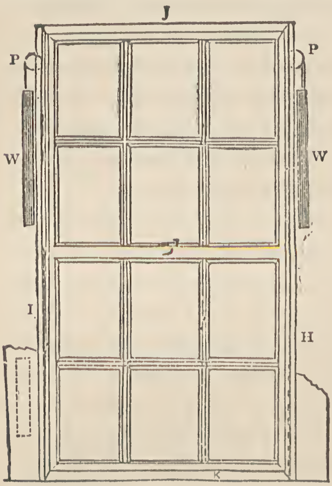


FIG. 413. WEIGHTS BALANCING WINDOW.

Breakage of sash-line.

828. The question now is—how is the damage to be repaired? In the first place, some sash-line must be bought. The best sash-cord is made of flax, plaited; twisted rope is useless, for the very way in which it is made renders it apt to cause a weight attached to it to turn round, and it will tighten in wet weather,

Mending broken sash-line.

and get longer in dry weather after the manner of all kinds of cord, causing it to be unfit for the purpose under consideration. Amateurs requiring sash-cord for repairs should get Austin's "Patent Flax Sash Line," the most useful sizes are Nos. 4, 5, and 6, sold respectively at 7d., 9d., and 11d. per knot of 12 yards.

Description of interior of frame.

829. To understand what course to pursue under such an emergency an inspection of fig. 414 is necessary, which shows a section of the frame on the right-hand side of the window. In this F is the space without the lower sash, which is occupied by the wooden window-sill ; B is a section of the right-hand upright of the lower sash ; C is the bead within, and E the parting-bead, which act as guides to keep the sash B in its place, and with A form the groove in which it works up and down on the right side; the upper sash working in the groove formed by E, the continuation of A and the projecting edge G of the board H, which forms the outside of the frame or box in which the weights work. The front of the box is formed by the board A, K being another board which forms the inside of the frame towards the room. A parting-bead L is inserted which divides the box into two parts, one for each weight, and keeps the weights from clashing one against another in their passage up and down. The frame is completed by another board, which goes across from H to K, parallel to A, and to which the boards H and K are nailed.

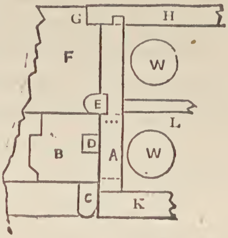


Fig. 414. Section of sash-frames showing weights, etc.

How to take out sash.

830. Supposing the cord which attaches the weight W to the right-hand side of the sash B is broken, the amateur must first proceed to remove the bead C on the right-hand side of the window, lifting it out of its place with a chisel. This will not be very difficult, as it is merely bradded in its place by thin nails ; care should be taken not to injure the paint more than can be helped. The bead C being withdrawn, the sash B may be easily slipped out of its place, and the side exposed to view, in the upper part of which is a shallow groove D, just deep enough to hold the sash-cord, and in which the end of the broken cord will be found to be nailed by two or three clout nails, or nails with flat, round heads. The nails must be pulled out and the cord removed. A close inspection of the side of frame will show the amateur where the "pocket" A is. This is a long slip of wood nearly as broad as the groove in which the sash B moves ; it is fitted tightly into

The pocket in frame : how to find it.

a long slot cut for its reception, but may be easily lifted out with a chisel. The top of the weight will then be visible, this must be taken out and the cord removed. The next point is how to get in the new cord. To effect this a piece of twine must be attached to one end of the new piece of sash cord, and a small piece of chain to the twine. The chain must then be passed over the pulley into the frame. Its weight will soon take it to the bottom of the frame, dragging the twine with it, by means of which the sash cord may be drawn into the frame, over the pulley, and brought out at the bottom. The cord must then be knotted to the weight, and the weight returned to its place, and the piece of wood that has been removed fitted carefully into the slot from which it was taken. It now remains to nail the cord to the frame, and to determine the proper length at which it must be cut off; the weight must be pulled up nearly to the top, and the cord cut off about 8in. or 9in. below the lower rail of the top sash; the end must then be laid into the groove D, and attached to the frame of the sash with nails. The sash may then be replaced and the bead C restored to its original position, which completes the operation. When it is necessary to take out the top sash, the bead C and the lower sash must first be removed, after which the parting-bead E must be slipped out, which is a matter of no difficulty, as the bead is merely dropped into a groove ploughed in A from top to bottom for its reception.

Weight to be taken out.

How to get in new cord.

Knotting cord to weight.

Nailing cord to frame.

Replacement of sash, bead, etc.

831. Windows and doors, from one point of view, may be described as the means by which ingress and egress are afforded to and from any room or enclosed space. It may be objected that windows do not generally afford this, which is true to a certain extent and under certain circumstances, for persons are often compelled to enter and quit a house by a window when the house is on fire; and some windows, as for example French windows, partake of the nature of doors and are used in precisely the same way. Thus the broad definition holds good, and as the bat is looked on as a connecting link between animals and birds, and the flying fish as a connecting link between birds and fishes, so may the French window be regarded as connecting the window proper with doors of all kinds.

Windows and doors: how defined.

832. In considering doors we may look on them, speaking generally, as divided into ledge doors and framed doors, the construction of which we will proceed to describe; after which it will be useful to say a few words on gates.

Classification of doors.

833. In fig. 415 is shown the construction of the ledge door. In order to do this clearly, and to exhibit the way by which it is attached by hinges to the side-post or frame, it has been necessary to make this illustration the elevation of the door as seen from the inside. Outside nothing more is seen than the lines in which the planks that form the door meet; and as match-boarding is generally used for doors of this description, the line of junction assumes the form of a bead. We may now proceed to show how the door is made.

Ledge doors: their appearance.

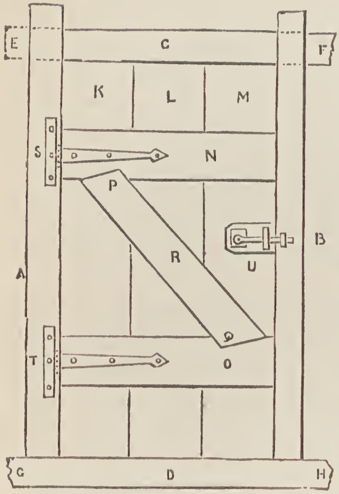


FIG. 415. THE LEDGE DOOR.

834. If the door is to be fitted to a framed wooden building, provision will have been made to adapt part of the framing as the jambs or side-posts and lintel; but if the door is to be inserted in a brick wall, or a wall of any other material, a frame must be made for its reception. In either case the principles of construction are the same, and as the amateur does not now require to be told how to make a frame for a door, we will take it for granted that the door is intended for some outbuilding that he has built of wood, for a workshop, or any other purpose. In this case A and B are two uprights, portions of the framing, mortised into the horizontal piece of wood D at the bottom, which serves as the sill of the door. At a suitable height, say 6ft. in the clear above the sill, a piece of quartering, C, is mortised, or notched, into the uprights, as may be most convenient. Mortising is strongest and neatest, and as the insertion of C should be provided for when the framing is in course of construction there will be no difficulty in putting in the lintel in this manner. If the frame is made separately for insertion in a wall, the ends of the sill and lintel should project beyond the uprights, as shown at E, F, G, and H.

Frame for ledge doors.

835. Now for the door. Suppose the width between the uprights to be 2ft. 3in., three pieces of match-boarding, ⅝in. or ¾in. thick and 9in. wide, will be sufficient for the vertical planks shown at K, L, M. These planks, it need scarcely be said, extend from top to bottom. Two ledges or slips of wood N, O, about 6in. wide

How to make a ledge door.

and ¾in. thick, are then placed horizontally, as shown in the figure; and to these the planks K, L, and M are nailed with *clasp nails*, which should be used because the ends can be turned and clenched in the ledges. These nails are driven in from the outside. When the door is a light one, two ledges are sufficient, but when it is large and heavy, it is better to use three ledges, one in the centre, and one near the top, and a third near the bottom of the door. To strengthen the door shallow notches are cut in N and O, at P and Q, to receive the corners of the brace R, to which the boards that form the door are also nailed and clenched. When three ledges are used two braces are required; these braces must be inserted in precisely the same manner as the brace shown in fig. 415.

836. The door is now complete, and all that remains to be done is to fix it in the position it is intended to occupy. In helping us to

How to fix the door.

understand how this is to be done, fig. 416, which shows the plan or section of the door through one of the ledges, will prove of service. The door must be fitted nicely into the opening and held in position between the jambs A and B, so that the outer surface of the ledges is flush with the inner surface of the jambs. Marks with a pencil must then be made to show how far the outer surface of the door projects along the opposite faces of the jambs. The door must then be removed, and stops, as shown by C and D, nailed to the sides of the jambs and the under surface of the lintel. The door must then be set against the jambs, and two thin pieces of wood inserted between the sill and the bottom of the door, so that the door may not drag or bear against the upper surface of the sill when it is opened or shut. A

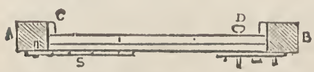


FIG 416.
SECTION OF LEDGE DOOR.

T hinges, or cross-garnets.

pair of T hinges, sometimes called *cross-garnets*, must then be screwed to the jamb A, and the ledges N, O, as shown at S and T in fig. 415, and at S in the sectional diagram, fig. 416. Hinges of this description vary considerably in size, the smaller sorts being used for box-hinges, and the larger kinds for doors, the lids of dust-bins, etc. For a light door, the tongue of the hinge, that is to say, the part which is screwed to the ledge, should not be less than 9in., and the cross-piece about 4in.; for a heavy door a larger and stronger hinge should be

Latch and fittings for door.

used. Lastly, the latch of the door must be put on, and this may be a simple thumb-latch, unless a spring-latch or a lock is preferred. If a thumb-latch is used, a small block of wood, U, must be fixed to the door, of the same thickness as the ledge, and to this the lifting bar of the latch must be screwed and

the iron loop within which it works, the catch into which it drops being screwed to the jamb B. A hole must be cut through the board M and the block U to admit of the insertion of the lever by which the bar of the latch is lifted. Such is the ledge door, and as this is the kind of door which will be chiefly made by the amateur for his sheds, tool-houses, and outbuildings of every description, except greenhouses, care has been taken to describe every part of it, and to show its construction and the mode adopted in "hanging" it, as clearly and fully as possible.

837. A framed door is much more elaborate in its construction, and consists either of a simple single panel in a frame, as used for dwarf cupboards, or two, four, or six panels, enclosed between styles and rails. The reasons why doors are made in this manner are, firstly, because they present a better and far more satisfactory appearance than a door with an almost plain and unbroken surface as a ledge door; secondly, because it is far lighter than a door would be made of the same thickness throughout as the wood which is used for the styles and rails; and thirdly, because less wood is used in its construction. This effects a saving in the cost and quantity of material used; but this, when the door is made by a carpenter, is counterbalanced by the extra time taken in making, and the consequent extra cost of labour.

Framed doors.

Why framed doors are used.

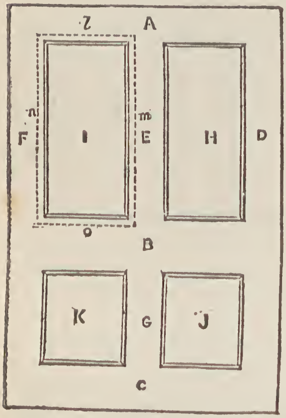


FIG. 417. FOUR-PANELLED FRAMED DOOR.

838. As a suitable example of a framed door, we may as well take a four-panelled frame door, because it will afford the key to the mode of making most doors of this description, whatever may be the number of panels used, whether one, two, four, or six. In fig. 417 the door is shown complete, when all the component parts have been put together. The parts are three rails, or cross-pieces A, B, and C, of which B and C are always wider than the top rail A; two long styles, D and F, forming the sides of the door, and two short styles, E and G, in the centre between the rails; lastly, there are four panels, H, I, J, and K, which are inserted in grooves cut in the styles and rails for their reception as shown in the figure by the dotted lines *l*, *m*, *n*, *o*. With regard to the dimensions of the door and its different parts, these must be left to the amateur that

Parts of a framed door.

Rails, styles, and panels.

he may adapt them to his special requirements. It may, however, be said that the panels are generally made of sound straight-grained ½in. stuff, and that the styles and rails of wood range from 1¼in. to 2in. in thickness; the styles are generally about 4in. in width, the top rail about 5in. or 6in. wide, and the middle and bottom rail about twice the width of the top rail.

839. Let us turn now to fig. 418, in which every piece that enters into the construction of the door is shown separately in its entirety—that is to say, exhibiting the tenons of the rails and the full extent of the panels. All the pieces, moreover, are in the position they occupy relatively to one another, and in which they must be placed before the tenons are glued up, and the component parts all brought together. An examination of the figure will show that tenons must be cut at *a* and *c* in the rail A, *e* and *f* in B, and *g* and *h* in C, which fit into corresponding mortises in the styles, shown by the same letters, namely, *a*, *c*, and *g* in D, and *c*, *f*, and *h* in F; tenons are also cut at the ends *b* and *d* of the short style E, and at the ends *i* and *j* of the short style G, which fit into mortises similarly lettered in the rails A, B, and C.

Construction of separate parts of door.

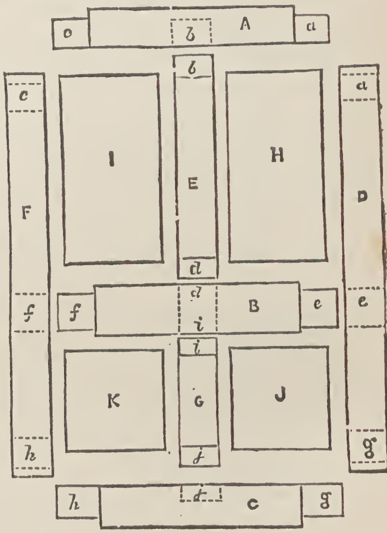


FIG. 418. PARTS OF FRAMED DOOR.

FIG. 419.
SECTION OF FRAMED DOOR.

In the *inner edge* of the two long styles and the top and bottom rails, and on *both edges* of the short styles and centre rail, grooves must be ploughed about ½in. deep to receive the edges of the panels, which, therefore, must be made about 1in. wider than they seem to be when the different parts of the door are all brought together. This is clearly shown in fig. 419, which is a section of the door across the upper panels I and H and the styles D, E, F. In doors for offices and ordinary purposes nothing more is done, but in doors for houses it is usual to finish the inside of the door—that is to say, the side which is seen from the room to which the door is fixed—with a moulding, as

Grooves for panels.

shown in figs. 417, 419, and on a larger scale in fig. 420, in which A is the style in section, B the panel, and C the moulding. The moulding should be of such a thickness as to be flush with the styles and rails in its thickest part. When a six-panel door is made, the second rail from the top is technically known as the "frieze" rail, the others retaining their ordinary names as for the four-panel door. In all doors of this description the middle rail is sometimes called the lock-rail. In making entrance doors and all doors in which great strength is required, and frequently in doors in which the styles and rails are not more than 1¼ in. in thickness, the panel is rebated, as shown at D in fig. 421, so that one side of the panel may be flush with the style. When this is done it adds very much to the appearance of the door if a bead is run round the edge of the rebated part of the panel, as also shown at D in fig. 421.

Moulding in panels.

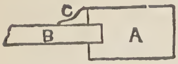


FIG. 420. MOULDING IN PANEL.

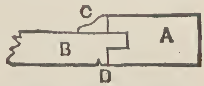


FIG. 421. PANEL FLUSH WITH STYLE.

840. As the doors of rooms as a rule open inwards, the stops must be put on, as in the case of the ledge-door above described, on the outside. It may be said as a general rule that all doors, whether of rooms or of cupboards, open into the room; thus far the doors of rooms and cupboards are similar; but in one respect they are not similar, and that is in this, that whereas the room door opens *inwards* into the room to allow of ingress or egress, as the case may be; the door of a cupboard opens *outwards* from the space enclosed and shut in by the cupboard door or doors and their frame, so as to give more ready means of access to the interior of the cupboard and those things which have been placed in it.

Position of stops.

841. All doors of rooms and cupboards are hung with hinges technically called butts. These hinges are made of two pieces of cast iron of equal size, longer than they are wide in the proportion of about three to one, furnished at the inner edge, one with two or three loops, and the other with one or two loops. Thus in fig. 422, which represents a butt hinge, the three loops *a a a* are on the inner edge of the flap A, and the two loops *b b* are on the inner edge of the flap B. The loops *b b* are inserted between the loops *a a a*, and a stiff pin on which the flaps turn is passed through the loops, which are perforated to receive it. Hanging a door or window is a delicate and troublesome operation. When the hinge is closed, the edge of the style of

Butt hinges.

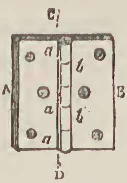


FIG. 422. BUTT HINGE.

the door on one side and the door-jamb on the other should not extend further than the dotted line C D in fig. 422. The method of fixing hinges will be more apparent from fig. 423, in which the back of the flap B is shown closed down upon A. This flap is buried to its edge in the edge X Y of the style of the door, a depression of suitable size having been cut out with a chisel to receive it. In the same manner the flap B is sunk in the door-jamb, until its inner surface is flush, or indeed a little below the surface of the door-jamb. To make the door complete, a mortise or rim-lock must be added to it, with the necessary fittings. Of these, a mortise-lock is embedded in the style in the centre of the middle rail, but a rim-lock is screwed on the inner face of the middle rail of the door. As the general construction of locks will be noticed elsewhere in this work, no further description of the principles on which they are made will be required here. The utmost nicety is required in regulating the depth to which the flaps of hinges must be sunk in the wood. If by some mischance too much of the wood has been removed, a thickness or two of cardboard or coarse brown paper must be let into the groove to diminish the depth. Very few will hang a door or casement window or French window so as to work with perfect ease at the first essay, and even an experienced hand will sometimes spend an hour or two over a job of this kind.

Hanging door a difficult operation.

Fixing the hinges.

Sinking hinges in work.

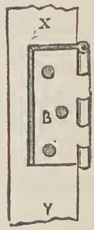


FIG. 423. MODE OF FIXING HINGE.

842. The styles and rails of cupboard-doors, for cupboards, cheffoniers, wardrobes, bookcases, and all kinds of articles of this description, are made of thinner wood than that which is generally used for the styles and rails of room-doors. A modification of the construction described above for frame-doors will therefore be necessary, and we will now proceed to give some idea of the principal points which characterise this modification.

Styles and rails for cupboard-doors.

843. For a simple cupboard-door two styles and two rails may be framed together, as shown by figs. 424, 426, the former of which represents one corner when seen from within, and the other another corner of the same frame seen from without. Both styles and rails are rebated, as shown by the shaded part in fig. 424 and in the sections represented in figs. 425, 426. Into the rebate a panel is dropped, which is secured in its resting-place by brads. The panel is shown at A in fig. 425, and at B in fig. 427. The panel may be finished by a moulding, as at C, but a very nice appearance is

Construction of simple cupboard-door.

given to a door of this description by a bead slightly rounded on the exterior, as shown at D in figs. 426 and 427, and put on in place of the moulding C. This bead is preferable to a moulding in all pieces of furniture which are stained and varnished or French-polished. It should project slightly beyond the face of the frame of the door. When it is found necessary to make a temporary wardrobe in a recess, or indeed to fit up a recess as a hanging closet for dresses, coats, etc., a very light, pretty, and ornamental door may be made by dropping into the rebate of the frame, another frame, as shown between the dotted lines at E in fig. 425, made to fit into the rebate with tolerable ease, over which some chintz or cretonne has been strained. This fabric will be as effectual as the panel of a door in keeping out dust, and the extra thickness of the material when passed over the edges of the frame and nailed to it on its inner surface will make the frame fit tightly into the rebate, to which it must be secured with a brad here and there.

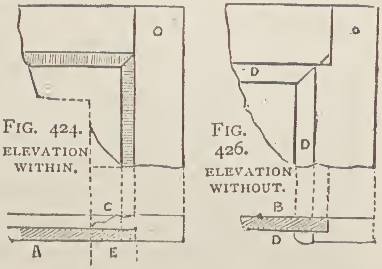


FIG. 424. ELEVATION WITHIN. FIG. 426. ELEVATION WITHOUT.

FIG. 425. SECTION. FIG. 427. SECTION.

MODES OF MAKING CUPBOARD DOORS.

Temporary door for hanging closet.

Conclusion of remarks on doors.

844. Here we must bring to an end our remarks on doors and the method of making them. The reader must remember that it is impossible to describe pieces of furniture in completeness of detail in every part, as, for example, to give directions for making a cupboard, wardrobe, or bookcase, and go into the minutiæ of door-making, with each article ; but from what is said here on the modes of making different kinds of doors the amateur need not be at a loss how to proceed when he is engaged in making any of the articles that have been mentioned. The information given has, in all cases, been rendered as broad and general in its application as possible, so that with regard to any branch of carpentry, joinery, or building work, what is merely hinted at in one part of the work, taken as a whole will be found fully and minutely described in another. The object chiefly in view has been to help the amateur to make anything and everything that it is possible for him to make, and not to give detailed descriptions of a few articles with regard to length, breadth, and thickness of every part, and the manner in which these parts must be put together.

845. The amateur artisan will perhaps be sometimes called on to

make a gate, which is nothing more than a door formed of styles and bars or pales instead of being solid. The various ways in which gates may be made are well-nigh countless, and all that can be done here is to describe the general principles on which gates of all kinds are made. For this purpose it will be enough to describe and illustrate the ordinary field-gate, a little wicket-gate, and a garden-gate of rather more elaborate construction intended to close the entrance from the roadway into a garden in front of a house.

Gates of different kinds.

846. First, let us take the ordinary field-gate, which is represented in fig. 428. In this the supports of the gate are formed by two stout posts, A, A, the lower end of each, B, B, being left rough so as to give them better holding when put in the ground. A hole having been dug for the posts, they must be set upright by aid of the plumb-level and then surrounded with brick-bats, stones, gravel, lime core, etc., which must be beaten in tight with a rammer. To make the gate two styles, C, D, are first cut out, the style C, to which the hinges are fixed, being called the hanging style, while the style D, to which the latch is fastened, is called the falling style. Five or six rails, as G, G, G, are then mortised into the styles and wedged up as tightly as possible. The hinges, E, F, are put on along the top and bottom rails. They consist of a loop of iron, which slips over a staple driven into the gate-post, and two tongues or straps of iron which pass along the top rail on either side, bent to clasp the rail as well as the hanging style, and pierced at equal intervals with holes, through which small bolts are driven and riveted. It will be obvious to the reader that the gate, being longer than it is wide, will by its weight exercise a great strain on the hinges, and have a tendency to drop towards the ground at B. To prevent this, and to keep the end of the falling style

Ordinary field-gate.

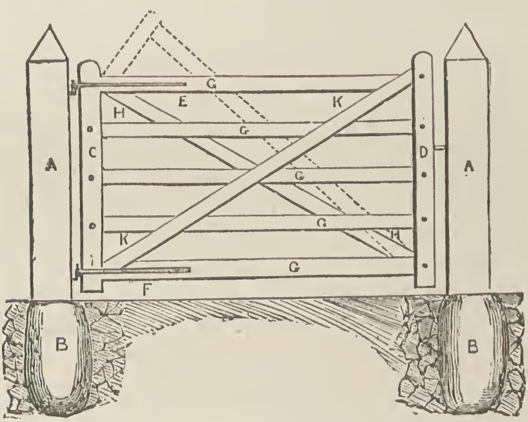


FIG. 428. ORDINARY FIELD-GATE.

Posts or supports.

Construction of gate.

from touching and dragging along the ground, struts, H, K, should be put across the gate from corner to corner, by which the strain is taken off the rails and thrown on the bolts and straps of the upper hinge. The ends of the struts are butted against the styles. Sometimes only one strut is used, and in this case it does not matter in which direction the strut crosses the gate. Sometimes, in order to increase the angle at which the strut crosses the rails, or, in other words, to render it less acute, a piece of timber is mortised to the hanging strut, projecting in a direction slanting upwards over the plane in which the rails lie, and the strut is brought between the end of this projecting piece and the bottom of the falling style, as shown by the dotted lines in the illustration.

The strut and its use.

847. When a light but strong gate of this description is desired, the strut and styles are made of the same thickness and framed together in the same plane. Holes are then bored through the styles and the strut, through which round bars of wood are driven and wedged up at each end.

Light but strong gate.

848. Field-gates are fastened with a hook attached to the gate and falling into a staple driven into the post, against which the gate falls. Park-gates and entrance-gates of this description have a hole cut in the falling style, through which a short, flat piece of iron curled at one end is passed. This iron works on a pin driven through both style and iron which is pierced for the purpose, and the gate is secured by the bar dropping into a notch cut in the piece of iron of some thickness, which is attached to the face of the falling post.

Fasteners for gates.

849. When making a small gate of this description, the amateur may save himself the trouble of cutting and planing out round bars by buying a few broom-handles, which may be bought for 2d. each of most ironmongers, oil and colour men, and others who deal in brooms and brushes. The same handles make a neat fence when inserted at equal distances in two parallel and horizontal rails made to receive them and mortised at convenient lengths, say from 9ft. to 12ft. in stout uprights. They may

Simple method of making small gate.

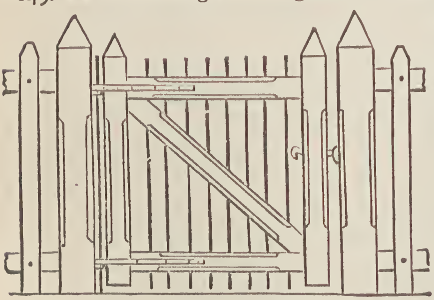


FIG. 429. GARDEN OR WICKET GATE.

also be used instead of iron bars in making a little garden or wicket gate, as shown in fig. 429; but as the wooden bars are much larger in diameter than the iron ones, the styles, rails, and strut must of course be made in proportion. In the gate exhibited in this figure the rails and strut are a trifle narrower than the styles into which they are mortised, and to give lightness of appearance the top rail and strut are chamfered. This may also be done with regard to the lower rail and styles, although it is not so shown in the drawing. Holes are then bored in the top and bottom rails and the strut, through which bars of iron are driven. Hinges, consisting of loops and straps, are fastened to the rails as in the gate above described, and these hinges rest on perforated plates driven into the hanging post or otherwise secured. A vertical bar is then passed through loops and plates, on which bar the gate swings.

Gate at top of flight of stairs.

850. A handy gate of this kind for the head of a flight of stairs to keep young children from accidents from falling downstairs may be made with very little trouble, laths about ⅜in. thick and 1½ inches wide being nailed to the rails and strut instead of iron bars. The gate may be hung to a piece of wood about 1in. in thickness, attached to the wall or the newel at the stair head as may be most convenient, the falling post consisting of a similar piece of wood attached conversely to the newel or the wall as the case may be.

Garden-gates.

851. For a garden-gate, closing the entrance from a roadway to a garden, the kind of gate just described will not be sufficiently ornamental in character, though it may be substantial enough for all purposes for which it is required. In this case the amateur will have to make a gate altogether different in description. An infinite variety of designs are to be had or made for gates of this class, but the most convenient will be found to be a gate that is solid below and pierced above for lightness' sake, because it is better adapted for keeping passing dogs out of the garden.

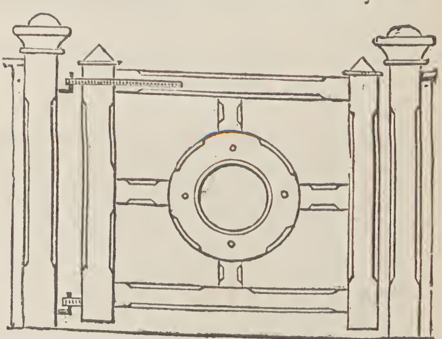


Fig. 430. Garden-gate.

852. In fig. 430 a good type of gate is shown, consisting of a central

circle chamfered and attached by the four arms of a cross, also chamfered to the styles and rails. It will be noticed that in the drawing the centre and corners are left open purposely, because there are many different modes of treating them. It is objectionable to leave them unfilled, because animals, such as cats and dogs, can go in and out through any of the openings at pleasure. The whole of the openings may be furnished with vertical bars ; or the lower corners may be panelled, the upper ones and the centre being barred ; or all the openings may be filled with iron castings which may be bought for this purpose ; but in this case the castings must be obtained first of all and the frame of the gate then made to suit them. If the amateur completes the sketch of this gate on a larger scale, he will be the better able to judge of its general effect. In fig. 431 a massive garden gate of Gothic character is shown. The principal parts of this gate are the styles and cross rails, which are fastened together by tenoning the rails into the styles. The lower part of the gate is filled with substantial boards, forming one large panel. In the upper part the corners are filled with pieces cut to form an oval or ellipse on each face, but chamfered or hollowed within so as to form four points springing out from the under edge of the curve. The open centre is partly filled with a simple ornament in wrought iron, consisting of flat bars halved together at the centre, and having shorter pieces springing from each side of the arms of the cross. The extremity of each arm may be finished with projecting pieces, as at A, for attachment by screws to the inner edge of the oval.

Good gate for garden.

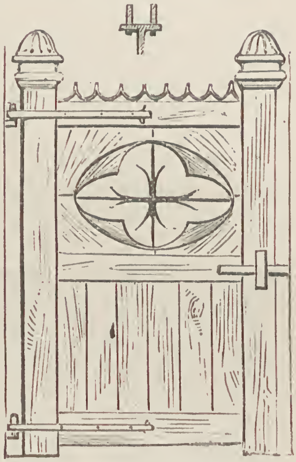


FIG. 431. GOTHIC GARDEN-GATE.

Construction of gate.

CHAPTER VIII.

BOXES, DRAWERS, PIGEON-HOLES, CHEST OF DRAWERS, WARDROBE, CUPBOARDS, BOOKSHELVES.

Boxes and Drawers—Chest of Drawers—Meaning of the word "Box"—Various kinds of Boxes—The Window-box—Construction of Boxes of this kind—The Nail-box—Principles of Construction—Housemaid's Box—Box for Knives or Plate—Procedure in making Boxes—Ornamentation of Window-box—To make Window-box stand level—Pierced Panels—Zinc Box or Lining—Drainage of Window-box—Virgin Cork: its Use and Price—Ornamentation with Split Rods—Boxes with Lids or Covers—Cover of ordinary Box—Fittings for Wooden Boxes—Hinges for Boxes—Locks for Boxes—Handles for Boxes—Construction similar for all kinds of Boxes—The Tool-box—Methods of arranging Interior—Lid with Rim—Bottom of Box for large Tools—Leather for small Tools—Locker for Chisels, etc.—Recess for Glue-pot, Oil, etc.—Another mode of arrangement—Handles of Rope—Construction of Lid—Trays for Tools—Trays in form of Drawers—Travelling Trunk or Box—Construction of Travelling Trunk—Case, or lower part of Box—Top of Box—Hinges and Hasp-lock—Division of Interior into Compartments—Tray within Box—Use of Domed Top—Boards need not be Planed without—Hinges, Tapes, etc.—Materials for covering Box—Mode of putting on Covering—Flap of Leather round Cover—Flap over Lock of Box—Straps and Buckles—Angle Irons to strengthen Box—Drawer: what it is—Drawers in many Articles of Furniture—Principles of Construction of Drawers—Front, Back, and Sides—Bottom of Drawer—Runners for Drawers—Pigeon-holes—Construction of Pigeon-holes—General Rule for Construction—Ornamentation of Pigeon-holes—Analogy between Pigeon-holes and Chest of Drawers—Frame-work of Chest of Drawers—How Frame-work is constructed—Sides and Bottom of Case—Cross-pieces—Ledges in Interior—Back of Drawers—Top of Drawers—Legs, etc.—Fronts of the Drawers—Cupboards Fixed or Movable—Cupboard in Recess of Room—Treatment of Skirting—Frame for Door or Doors—Rail across Frame—Top of the Cupboard—Shelf or Shelves within—Dwarf Cupboard in Recess—Small portable Cupboard—Example of Portable Cupboard and Desk combined—Desk to project beyond Cupboard—Old-fashioned Three-cornered Cupboards—Construction of Three-cornered Cupboard—To increase holding capacity—Cupboard: how Supported—The Wardrobe—General arrangement—Proportions of Wardrobe—Thickness of Timber used—Box for Bonnets, etc.—Compartment with Trays—Drawers at Bottom—Plinth—Connection of Body and Plinth—Doors for Compartments—Glazed Panels—Kitchen Dresser—Construction of Dresser—Slab for Dresser-board—Back of Dresser—Drawers in Front—Pot-board—Uprights for Shelves—Ledges: why nailed on Shelves—Hooks for Jugs, etc.—Appropriation of Shelves—Why sides of Dresser should be high—Space behind Shelves—Bookshelves—May be made of simple Materials—Bookshelves of Boards of Egg-boxes—To make thin Boards look substantial—Formation of Cornice—Leather Strips on Shelves—Brackets under Moulding—Good

Designs for Bookshelves—Shelves in Dwarf Cupboards—Extension of sides—Simple and useful Bookshelves—How to Construct them—Made in Compartments—Structure of End-pieces—Standards between End-pieces—How to put Parts together—Board at Top—Cornice and Brackets—Bottom of Bookcase—Uses of space below Bottom Shelves—The Shelves, and how to finish them—Bookcase on this Principle may be extended or diminished—Doors not recommended—American Bookcase on Expansive Principle—Plan of Construction—This mode suitable for those who change Houses often—Furniture for Book-room may be made by Amateur—Leather Cloth on edges of Shelves.

853. IN all the various articles to be treated in this chapter there is a certain degree of similarity. As a rule, all of them are rectangular in form, the chief exceptions being the chest of drawers with circular or elliptic front, and the old-fashioned three-cornered cupboard fitted into the angle or corner of a room, but now very seldom used. Boxes and drawers are rectangular receptacles devoted to various purposes, and differing somewhat in construction according to the purpose for which each is intended; but, putting aside minor differences of construction, a box may be regarded as a drawer with a cover to it. Again: what is a chest of drawers but a set of pigeon-holes on a large scale, fitted, for greater convenience, with drawers that move in and out of the pigeon-holes. Thus it will be convenient to begin with the simplest form of box, and so proceed onwards, as the construction of one kind of article in the above category generally proves the key to the construction of another.

Boxes and drawers.

Chest of drawers.

854. The word *box*, in its primary signification, means "a hollow wooden case:" the term is applied to cases without covers as well as cases to which covers are attached. The simplest form is to be found in the window-box for plants, which, when it is devoid of all ornamentation, consists merely of four sides and a bottom. The amateur mechanic's nail-box, and the housemaid's box for blacking brushes, etc., are merely modifications of the window-box, on a smaller scale as regards length if not in breadth. The knife-box or knife-tray, and all boxes of this description for household use, to hold cutlery and plate, are closely akin in form to the boxes that have just been mentioned. Let us first see how boxes of these kinds are made.

Meaning of the word "box."

Various kinds of boxes.

855. The length and breadth of the window-box must be governed in all cases by the dimensions of the window-sill on which it is to stand. Supposing that it is desired to make a plain box devoid of ornament, and in the simplest manner possible, all that has to be done is to cut out the ends and the sides of the intended box, and then to nail the long sides to the short ends. A frame

The window-box.

is thus formed, and all that is necessary to be done to convert the frame into a box is to nail on a piece of board of the requisite size to form a bottom. Additional strength may be given to all boxes and cases constructed in this manner by nailing strips of iron, bent so that one half is at right angles to the other half, at each corner of the box, and over the sides and bottom.

856. Now in making a box in this way, which is the plan generally adopted for common boxes and packing cases of all kinds, no very great amount of skill is required. All that is necessary is that the various parts should be cut square, so that the box itself may be truly rectangular in form when completed. There is another method which is sometimes adopted in making small boxes, such as nail-boxes, etc., and that is to plough grooves in the sides at each end, into which the pieces that form the ends of the box may be dropped, as shown at B in fig. 432; the other side, A, of the same figure exhibiting the mode of simply nailing the parts together when flush, as previously described. The amateur carpenter who has gained a tolerably intimate knowledge of his business will choose neither of these methods when he wishes to form a stout and strong case, but will dovetail the ends and sides together in a truly workman-like manner; and when he does make a box or case as described above, as well as in the best possible manner, he will—unless the projecting edge is likely to be in the way, as it would be in some cases—allow the bottom to project slightly beyond the sides, as shown by the dotted lines in the above figure, and round off the edges so that they assume the form of a bead or circular moulding. This mode of procedure is most desirable for a nail-box, housemaid's box, or window-box.

Construction of boxes of this kind.

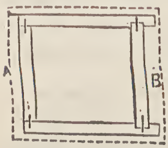


FIG. 432. SIDES AND ENDS OF BOX NAILED TOGETHER.

857. As a general type of boxes of this kind let us take the nail-box, because this is a box which every amateur artisan must have. The elevation of a box of this kind, when viewed from either side, is shown in fig. 433, the plan in fig. 434. It may be as large as the maker pleases, but a box from 12in. to 15in. long, 9in. or 10in. broad, and 2½in. or 3in. deep, will be found the most convenient size. The sides and ends of the box must first be framed together, the tenons being cut on each side of the ends, and the dovetailed notches, into which they are dropped, in the sides. Before the ends and sides are put together grooves must be cut at A and B in the ends to receive the central par-

The nail-box.

Principles of construction.

tition A B, which should be nearly twice as wide as the sides. This piece of wood must be cut in the shape shown at C in fig. 433, and pierced with a longitudinal hole, as at D, for convenience of carriage. Grooves must then be made in the sides at E, F, and G, and in the central partition at H, K, and L, to receive the partitions E K, H F, L G, the tops of which must be flush with the edges of the sides and ends. The side of the box with two partitions should be put together first, and the partitions secured from moving by means of brads driven into them through the sides. Then the partition E K should be inserted, and the remaining side put on; or, what may be better, the ends and partitions may be first bradded to the central piece, and then the whole locked together by putting on the sides. Lastly, the bottom must be put on, which should be nailed to the sides and ends, and project slightly beyond them, as shown in the plan in fig. 434.

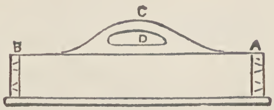


FIG. 433. NAIL-BOX (ELEVATION).

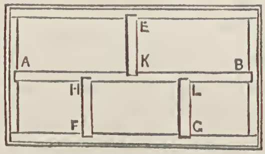


FIG. 434. NAIL-BOX (PLAN).

858. Now simple modifications of this kind of box will do for the housemaid's box, and the knife-box or plate-box. The housemaid's box will only require a central division and one subdivision, as at H F or L G in fig. 434, for the blacklead dish; an old jam-pot being as good as anything else for the purpose. The box for knives or plate will require the central division only, but it should be made of mahogany, and, when intended for silver, be lined with green baize. Sometimes knife-trays, especially when intended as a means for collecting them and carrying them from table after they have been used, are made with the sides and ends slightly sloped, so that the top is narrower and shorter than the area enclosed by the upper edges of the ends and sides.

Housemaid's box.

Box for knives or plate.

859. Thus for boxes of a plain ordinary description—and it may be noted here that the method to be employed in making boxes or cases of every description is precisely the same—first of all, the ends and sides are to be nailed or dovetailed together, and then the bottom is to be nailed on from the outside. No ornamentation is required or desirable in boxes of this description, but a little decorative work adds very much to the appearance of a window-box.

Procedure in making boxes.

860. The window-box represented in fig. 435 is light and tasteful in

appearance, and may be made in the same pattern in various ways.

Ornamentation of window-box.

The ends, the back, and the bottom may be made of plain timber in the usual way, but the front is framed of two rails

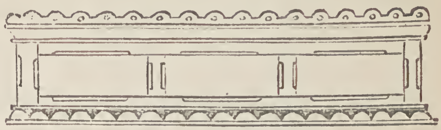


FIG. 435. WINDOW-BOX.

and four uprights, which are stop-chamfered, as shown in the illustration. The uprights divide the front into three compartments. The panels may be filled with tiles, or framed of wood sunk sufficiently below the framing to admit of an overlay of fret-cutting. An ovolo moulding is added above the frame, and this moulding must be returned round the sides. The edge of the bottom board, on which the framed front rests, and the edges of the same board at the sides are moulded, and below the moulding a slip of wood cut in scallops is affixed. This serves to break the interval between the bottom of the box and the sill of the window. The space left here is owing to the slope of the window-sill. It is necessary that the

To make window-box stand level.

box should stand level, and therefore slips of wood, as shown at A and shaded in fig. 436, should be nailed to the bottom of the box, one at each end and one in the centre, or even more at equal distance from each other and from the slips at the ends, if the box be more than 3ft. in length. The piece of

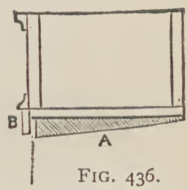


FIG. 436. SUPPORTS OF WINDOW-BOX.

wood, B, nailed to the edge of the bottom will hide the space between the bottom of the box and the front edge of the window-sill. The

Pierced panels.

pierced panels may be treated in various ways. If the frame and panels are of dark wood, a piece of light wood may be put in behind, so that the circles and triangles will show in agreeable contrast to the frame. Tiles may also be set behind the pierced panels; or, as it is desirable to have a zinc lining for such

Zinc box or lining.

boxes as these, the zinc front of the inner receptacle will serve to fill the open spaces, and may be painted or treated according to the taste of the maker. The zinc box which is dropped into the outer case should be made of stout zinc, and wire rings should be attached to the ends by which it may be lifted out of the case when necessary. Before plants are placed in this case, whether in pots or

Drainage of window-box.

out of pots, provision should be made for carrying off the surplus water after watering by means of a short pipe at one corner to which a tap is attached. When plants in pots are placed

in the case, and the interstices between the pots filled with moss, which will tend to keep the pots cool and moist, no crocks, etc., need be put at the bottom of the zinc case; but if the case is to be filled with earth the bottom must be crocked to the depth of 1in. at least. That the water may the more readily escape, the bottom of the zinc case should be made so as to fall from one end towards the other at which the water is to be drawn off.

861. The amateur will discover for himself many desirable methods of ornamenting the front of a window-box. One of the most suitable modes of doing this is to cover the entire front with the bark of the cork tree, commonly called "Virgin Cork," which may be procured from the VIRGIN CORK COMPANY. The price charged for this material is generally about 1s. 9d. for 7lbs., but in larger quantities it may be obtained at lower rates. Another very effective mode of decorating the front of a window-box is to cover it with pieces of hazel or other wood with the bark on, disposed in patterns all over the surface.

Virgin Cork: its use and price.

Ornamentation with split rods.

The sticks or rods must be cut in short lengths, and then split or sawn in two, so as to present one flat surface, which is to be placed against the wood, and the other rounded, which forms the exterior of the front, and must be varnished or coated with boiled oil, the better to preserve it. Fig. 437 gives a good illustration of this kind of work.

FIG. 437. WINDOW-BOX.

862. We must now go on to consider boxes made with covers, the covers being attached to the receptacles or cases over which they are fitted by means of hinges. The sides and ends of all boxes must be, or had better be, dovetailed together, especially when the wood is not hidden from view by chintz, cretonne, or damask, or any other textile material, as in the case of an ottoman-box; or by leather, American leather-cloth, or painted canvas or hessian, as in the case of a trunk or travelling-box. We will first make a few general remarks on box-making, and then proceed to the general details of construction in making a tool-box, and a travelling-box, or clothes-box.

Boxes with lids or covers.

863. The cover of an ordinary box consists of nothing more than a piece of wood, or even two or three, glued up and clamped together if necessary, cut flush with the sides and ends of the box. A slip of wood or a rounded moulding is then put on round the edge of the cover, and this moulding comes from ¼in. to ⅝in. over the front and ends, and adds to the general appearance, while it serves to keep out dust, etc., which might otherwise more easily find an entrance into the box. This moulding is shown at A in the section of a box represented in Fig. 438. It is put on at the front and ends of the cover only; it must not be put on at the back, for if it were the box could not be opened. Sometimes, when it is desirable to make a very neat job and to conceal the edge of the bottom from view, the lower edges of the back, front, and ends are rebated as shown at B and C, and the bottom is then cut so as to drop into the rebate. Again, when the edge of the bottom shows all round, having been cut flush with front, back, and ends, and nailed to them, it may be hidden by a moulding, or slip of wood with a bead as the top, nailed round the bottom of the box, as shown at D and E, so as to form a plinth. Lastly, when boxes are intended to hold clothes, tools, etc., and to stand on the floor, it is desirable to nail a slip or ledge of wood to the bottom at each end and, if the box be a large one, in the middle, so that there may be a free passage for air right under the box, as well as around and above.

Cover of ordinary box.

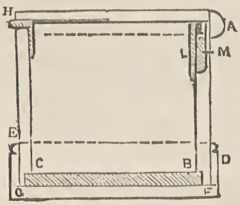


FIG. 438.
BOX IN SECTION.

864. The fittings used for a wooden box are three in number—the hinges, the lock, and the handles. For small boxes, long, narrow brass hinges, made like the iron butt hinges, are used; but for larger boxes a hinge of the shape shown in fig. 439 is used. The manner in which this hinge is attached to the box is shown at H in section in fig. 438, but the general form will be better understood from fig. 439. A notch is cut in the edge of the back to receive the part A, and if a tray is to be fitted into the box the part B should also be fitted into a recess cut in the inner surface of the back for its reception. The strap C is simply screwed to the under side of the cover. Such is the ordinary box-hinge, which answers very much in general character to the T hinge, the principle being the same though it differs somewhat in shape.

Fittings for wooden boxes.

Hinges for boxes.

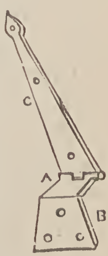


FIG. 439.
HINGE FOR BOX.

865. The ordinary box lock is shown in fig. 440. This must not be confounded with the hasp-lock used for trunks and portmanteaus, whose construction will be explained presently. The mode in which the lock is fixed is shown in section in fig. 438. First of all, an indentation of sufficient depth to receive the plate A (fig. 440) is cut in the edge of the front of the box, so that the upper surface of the plate may be flush with the edge of the box. The inner surface is then recessed slightly to receive the plate B, but a deeper hole or indentation is cut away to receive the box C, which holds the bolt, etc., of the lock. A hole must then be made through the front to admit the key, the barrel of which fits on over the peg or spike shown at M in the figure. Care must be taken not to cut away an atom more wood than is necessary to admit the box C, otherwise there will be nothing to hold the screws which pass through the four holes shown in the plate B, and which fasten the lock to the inside of the box. Lastly, the hasp D must be screwed to the inside of the top in such a position that it may drop easily into the lock as shown at E. There is no great difficulty in fixing a lock of this kind, but it is a piece of work of some nicety and requires time and care.

Locks for boxes.

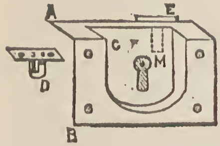


FIG. 440. LOCK FOR BOX.

866. Boxes, especially when filled, are heavy and awkward to move, and for this reason it is desirable that iron handles should be fixed to them, one at each end. The handles commonly used for this purpose are shown in fig. 441. To a plate in which are four holes for screws, two projections are attached. In these projections are holes into which are inserted the ends of a swing handle, the ends of the handle being constructed in such a manner that the handle will lie flat against the plate, or be turned upwards just so far that it stands out at right angles to the plate and no farther. The average prices of hinges, locks, and handles for boxes will be found in the price list of household ironmongery given in the last chapter of this section of the work.

Handles for boxes.

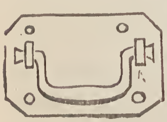


FIG. 441. HANDLE FOR BOX.

867. The remarks that have just been made refer to the construction of boxes generally, but they will be found applicable in many points to the boxes which we are now about to describe. Of these we will first take the tool-box, because it is one which the amateur must have, and which, without doubt, he will desire to make for himself.

Construction similar for all kinds of boxes.

The tool-box.

Methods of arranging interior.

868. The general mode of construction having been gone through in detail, it will only be necessary to exhibit convenient methods of arranging the interior. First, it is necessary to point out that the lid or cover of the box must be made deep enough to receive the tools that are shown as being placed within it; a depth of two inches will be sufficient. The rim of the lid should be of the same thickness as the sides and ends of the box, and made to fit exactly upon the lower case. A hasp-lock, such as is used for a trunk, will be suitable for a box of this description, but a box-lock may be put on equally well. Within the lid may be placed the hand-saw, tenon-saw, square, keyhole-saw, pincers, drill, and a few smaller tools. The best way of doing this is by blocks with thin brass buttons attached to turn over the tools and keep them in place, with some loops or ledges to take the blades of the saws, square, etc. Below, at the bottom of the box, large tools, such as planes, the wooden mallet, hone, and hammers, are kept, with the long large rasp used for wood. Along the back strips of leather are nailed to hold small tools, such as bradawls, gimlets, files, scribes, reamers, etc. The front of the box, it should be said, is removed so as to show the interior. At A is a small locker with a cover, which is useful for keeping such tools as the various kinds of bits that are used with the stock. In this locker chisels and gouges also may be stowed away. At B, C, D, E are trays divided into compartments for screws and various small pieces of ironmongery and brass ware that are frequently wanted in carpentry. The nails are better kept in the nail-box than within the tool-box; while below A, and covered with a sliding panel, like the sliding cover of a box containing a dissected puzzle, working in slips nailed to the sides of

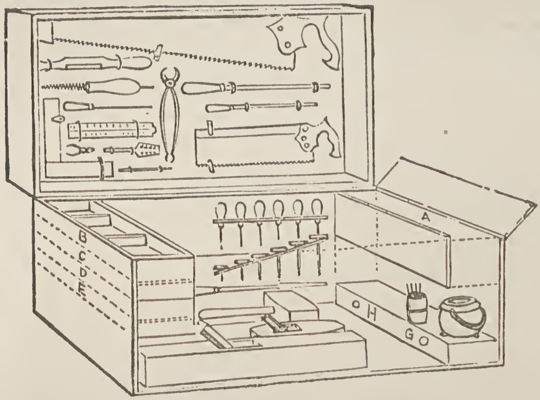


FIG. 442. INTERIOR OF TOOL-BOX.

Lid with rim.

Bottom of box for large tools.

Leather for small tools.

Locker for chisels, etc.

Recess for glue-pot, oil, etc.

the box, is a recess in which the glue-pot, oil-can, and bottles of varnish, etc., can be put away ; and at G, H are two small drawers, which may be dispensed with if the box is not deep enough for them.

869. The kind of tool-box just described will be found very useful by the majority of amateurs ; but for those who may not like this method of arranging the interior, and who may require more room, the accompanying longitudinal section, shown in part only, of a box 2ft. 9in. long by 16in. broad,

Another mode of arrangement.

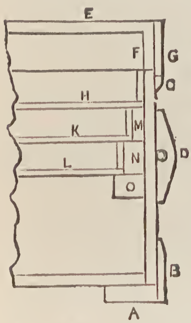


FIG. 443. INTERIOR OF TOOL-BOX.

may prove acceptable. This box is 21in. high, the thickness of the wood of which it is made and the depth of the different compartments within being shown in the figure. Ledges A, on which the box stands, are nailed to the bottom, and round both the upper and lower edges of front, back, and ends slips of wood are nailed, forming a plinth B below, and a projecting ledge C above. To the ends clumps of wood D are nailed, through which are passed pieces of rope to serve as handles. The lid E is made with a double rim, so that the inner rim F rests on the box, and the outer rim G on the ledge outside, nailed round the top of the front, etc., so that the box is dust-proof and almost watertight. Within are three trays, H, K, L, each about $2\frac{1}{4}$in. deep, resting on ledges M, N, O, graduated to take the trays, and screwed on to the ends inside the box. Below the third tray L is ample room for all large and heavy tools—such as planes, etc. ; the saws can be secured to the top of the box, within the lid, as in the foregoing example, and so can the square, bevel, etc. All the other tools can be disposed in the trays as may be most convenient. Some readers might object to this arrangement that considerable loss of time and trouble would be involved in lifting out and replacing the trays, in order to get at the tools which are stowed away in them. This, however, is obviated by making the trays just half the width of the box, and fixing rings or knobs to the front, by means of which they may be moved on the ledges from the back to the front of the box, thus exposing the interior of any of the trays without touching the others. Thus it will be seen at once that the tools in the bottom of the box can be taken out and put back again at pleasure without touching the drawers or trays. This mode of making a tool-box and fitting up the interior is recom-

Handles of rope.

Construction of lid.

Trays for tools.

Trays in form of drawers.

mended to the amateur carpenter as being both ingenious and convenient, enabling him to get at any tool he may require without a moment's delay or the slightest trouble.

870. Trunks and portmanteaus are expensive to purchasers, and are only used occasionally in travelling and in periodical visits to the seaside or elsewhere for change of air and scene. Increasing numbers in a family often renders an increase of articles of this description very desirable, and for the assistance of those who may wish to make such an addition to the baggage department, a useful form of travelling-trunk, equally adapted for ladies' or gentlemen's use, shall be described and illustrated. A trunk should be made in such a way as to provide three compartments below and a tray above for cloth clothes, dresses, etc., which are creased, or, to use an expressive though not elegant word, "crammed," by overmuch folding and squeezing.

Travelling trunk or box.

871. The general construction of a useful travelling-trunk, as suggested above, is shown in the accompanying illustrations, of which fig. 444 represents a section of the trunk, and fig. 445 the plan. Dimensions, as heretofore are left to the discretion of the maker, who will know his own requirements best; but for general purposes a box about 3ft. long, 18in. wide, and 15in. high will be found to be of useful size. First of all, the case or lower part of the box must be made in the usual manner, and as the box must be covered with leather or canvas, which should be painted, the sides, ends, and bottom may all be nailed together, to save the time that must otherwise be expended in dovetailing ends and sides. The cover must be made to fit exactly over and flush with the sides and ends. The top may be flat or rounded, as shown in fig. 444. There is no difficulty in making an arched or domed top; all that is requisite is to

Construction of travelling-trunk.

Case, or lower part of box.

Top of box.

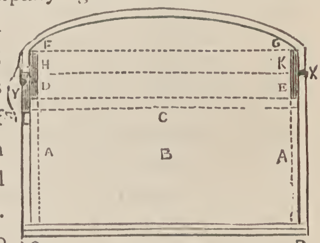


FIG. 444. TRAVELLING-TRUNK (SECTION).

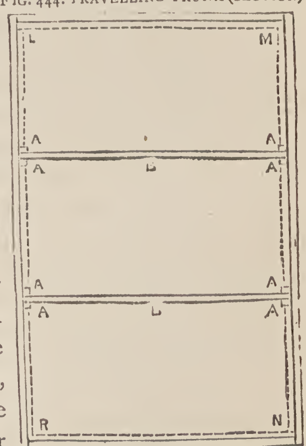


FIG. 445. TRAVELLING-TRUNK (PLAN).

cut the two ends of the cover in the form required, and then to nail boards across from end to end, bevelling the edges of the boards as may be necessary, so that they may be brought accurately and closely together. The case and the cover must be connected with hinges as at X, and a hasp-lock fitted on at Y; the lock itself being put on from the *outside* of the box, and the hasp that fits into it to the outside of the cover. We will speak presently of the mode to be adopted of finishing off the exterior of the box, and turn at once to the fitting up of the interior.

Hinges and hasp-lock.

872. The solid lines in each figure and the space enclosed between them show the boards of which the case and cover of the box are formed; to prevent confusion these lines are not lettered. To divide the box into three compartments, slips must be nailed to the sides, as shown in A in each figure. Each pair of slips forms a groove, and in the grooves thus formed a board B slips up and down, movable at pleasure, so that if necessary these boards may be removed, and the box thrown open from one end to the other. The utility of the boards, however, is manifest; for while the outer compartments may be closely packed with under-linen, etc., the central one may be occupied with hats and bonnets without any chance of their being crushed; or, if these be carried in a separate bonnet-box or basket, with boots and other articles that it may be desirable to keep apart from the wearing apparel.

Division of interior into compartments.

873. The tops of the slips that form the grooves, the tops of the boards that divide the box into compartments, and two ledges, screwed on, one to each end, inside, as shown in fig. 444 between the dotted lines C and D E, will form a sufficient support for the tray—which is a frame 3in. or 4in. in depth, with a few pieces of webbing stretched across it, and nailed to the edges to form a bottom. This frame is shown in plan in fig. 445 by the dotted lines L, M, N, R, and in section in fig. 444 by the shaded parts D F, E G. The dotted line H K merely shows the line in which the case and cover of the box meet. The tray should not be made to fit too tightly within the sides of the box, but so that it may slip in and out with ease. It will be noted that the tray projects above the top of the case from the line H K, and that the part above the plane that passes through this line projects upwards into the cover, which closes down over it when the box is shut. The use of the domed top is now obvious, for it is clear that there is more room for dresses, etc., that may be laid in the tray than if there had been a flat top to the box immediately above the line F G, fitting close over the tray.

Tray within box.

Use of domed top.

874. As the box is to be covered with some kind of material such as leather or canvas, there is no necessity to plane up the boards of which it is formed on the outside, but they should be nicely planed on the inside, which will do away with the necessity of papering the box within, which is resorted to by the professional trunk-makers, not so much for the sake of ornament or neatness, but to conceal the roughness of the boards which are left unplaned. For a box of the dimensions above given, sound board of $\frac{1}{2}$in., or at the utmost $\frac{5}{8}$in., in thickness will be sufficient. If the wood be thick enough three butt hinges of brass may be used, or hinges consisting of two straps connected by a pin may be screwed on from the outside, and made to form part of the ornamentation of the box. Strong tapes should be attached to the cover of the box at one end, and the case at the other, to prevent the cover from falling back too far when the box is opened.

Boards need not be planed without.

Hinges, tapes, etc.

875. Leather will be found far too expensive for the material to be used for the outer covering of the box, and the amateur will save the outlay which he must incur if he buys leather for this purpose by using canvas or hessian, which must be sized and painted black after it has been stretched over top and case and securely nailed to the edges. American leather-cloth has a nice appearance when first put on, but it is highly susceptible of injury from rough usage at railway stations, etc., when travelling. When the canvas has been put on and painted, a ledge of wood should be nailed all round the bottom to keep the bottom from coming into contact with any surface on which it may be placed, and which, possibly, may be wet, as in rainy weather. A flap of leather should be nailed all round the cover, except behind, and even there a strip of leather may be nailed along loosely, if it be thought desirable, to keep out the weather whenever the trunk may be exposed to the rain. The flap of leather should be nailed along the cover about $\frac{3}{4}$in. above the line H K in fig. 446, which, as in fig. 444, shows the line in which the cover and the case meet. In fig. 446, A B is this flap of leather, C a broad flap to cover and protect the lock, fastened down by straps and buckles D and E. A

Materials for covering box.

Mode of putting on covering.

Flap of leather round cover.

Flap over lock of box.

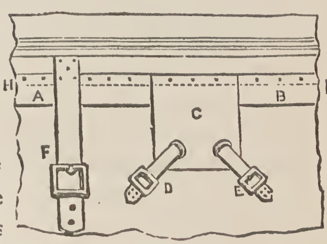


FIG. 446.
LEATHER FITTINGS TO BOX.

strong strap and buckle, as shown at F, should be placed on each side of the lock to take off part of the strain from the hasp of the lock. Lastly, angle-irons lacquered with black varnish should be placed along the edges of the box; those at the bottom having been put on before the ledge spoken of above is nailed to the bottom.

Straps and buckles.

Angle-irons to strengthen box.

876. A drawer is a box without a cover, made in such a manner that it may be easily pulled out from or pushed into a case or frame which is specially made to receive it. An assemblage of drawers, fitted into a single frame, is called, together with the frame in which the drawers are placed, a chest of drawers. Drawers enter into the construction of many articles of furniture, as, for example, library tables, kitchen tables, sofa and side tables, dressing tables, washstands, wardrobes, kitchen dressers, and cabinets; the principles of construction, however, are in every case the same, and on this account it will be more convenient to consider the construction of the drawer separately, without special reference to any article of furniture of which it may form a part.

Drawer: what it is.

Drawers in many articles of furniture.

877. A drawer, as a general rule, must be rectangular in form. The only exceptions to this rule are in drawers that fit into chests of drawers having rounded or elliptic fronts, when the front of each drawer must of necessity be curved in accordance with the shape of the frame in which it is placed. The way in which a drawer is made may be understood from the accompanying diagrams, of which fig. 447 represents the elevation of a drawer when seen from the side, and fig. 448 the section of a drawer. Fig. 447 shows how the front, back, and sides of a drawer are dovetailed together. As it is desirable that the front of the drawer should present one unbroken surface, the outer end of each side is dovetailed to the front, as shown at A. The details of this particular kind of dovetailing have been given in full in Part I., Chapter vii., and need not be repeated here. Grooves are made along the inner surface of the front and sides a short distance, say ½in. above the lower edge, to admit the bottom, which is made of thinner wood than the front, back, and sides of the drawer. The back of the bottom generally projects a little beyond the sides, as shown in both figures

Principles of construction of drawers.

FIG. 447. DRAWER (ELEVATION).

FIG. 448. DRAWER (SECTION).

Front, back, and sides.

Bottom of drawer.

at D, and the back of the drawer reaches to and rests upon the bottom, as shown between C and D in fig. 448. The mortises and tenons are glued up and the edges of the bottom are glued in front and at the sides, and the parts are then put together and closed up, nails being driven through the tenons of the sides into the front and back to aid in keeping the whole together.

878. The lower edges of the sides of the drawers, as shown at E F, act as runners on which the drawer is drawn out and run in. As the edges of the sides of the drawer are the only parts that rest on the framing within when the drawer is in motion, it is manifest that the friction is far less than it would have been if the lower surface of the bottom had been in the same plane with the edges of the sides. Sometimes the bottom is strengthened by putting small blocks in the angle formed by the lower surface of the bottom of the drawer and the inner surface of the sides just below the groove, as at G, H, K. When the knobs, which serve as handles to pull the drawer out and push it in, and the lock are put on, the drawer is complete. The prices of knobs, drawer-locks, and cupboard-locks of various sizes will be found in the last chapter of this part of "Every Man his own Mechanic."

Runners for drawers.

879. A very little consideration will serve to show that "pigeon-holes," into which letters and papers are thrust in such order as may be convenient to the person who makes use of them, and the framework which, together with the drawers, forms a chest of drawers, are intimately related; although the way in which pigeon-holes are made is by no means identical with that in which the framework of a chest of drawers is made. But one to a certain extent affords the key to making the other, and as the pigeon-holes are the simpler of the two we will consider these first.

Pigeon-holes.

880. Fig. 449 will serve to explain the principles that govern the construction of pigeon-holes as well as a more elaborate diagram showing a considerable number of holes. The size of the pigeon-holes and the length, breadth, and depth of the entire framing having been determined, two boards—A B, C D—must be cut and planed up for the top and bottom, and two—A C and B D—for the sides. Grooves must then be made in the top and bottom on the inner surface at E and F, for the reception of the vertical partition E F, and grooves must be made on each side of this partition at H and K, and in the inner surfaces at G and L, for the

Construction of pigeon-holes.

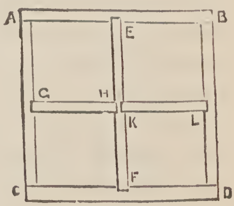


FIG. 449.
PIGEON-HOLES.

reception of the horizontal partitions G H, K L. When this has been done the pieces of wood A B, C D, A C, and B D must be put together—dovetailing at each angle of the frame is the most desirable and efficient mode of joining them—and then the upright partition E F must be gently driven into the grooves cut to receive it, and lastly the horizontal partitions G H, K L. In the small set of pigeon-holes under consideration it is unimportant whether the vertical or horizontal partition be in one piece. A safe rule for general guidance seems to be that *when the length of the pigeon-holes is greater than the height, the horizontal partitions shall each be in one and the same piece from side to side, the vertical partitions being grooved into them and the top and bottom; but when the height is greater than the length, the vertical partitions shall each be in one and the same piece, and the horizontal partitions grooved into them and the two sides.*

General rule for construction.

881. Such is the general method adopted in making pigeon-holes. Many modes of ornamenting them will readily suggest themselves to the amateur—as, for example, hiding the openings and their contents from view, and putting the latter beyond the prying inspection of other people, who may have access to the room or place where they are, by a pair of doors panelled and adorned with fret-work; but all this may be left to the maker's good taste, judgment, and requirements. They may be easily turned into a set of drawers for holding small articles, as is often done in chemists' shops and many houses of business, where a number of small, convenient receptacles for many different kinds of small articles are required. And when we have said this, the analogy between a set of pigeon-holes and the framing of a chest of drawers must be apparent.

Ornamentation of pigeon-holes.

Analogy between pigeon-holes and chest of drawers.

882. We will now proceed to a consideration of the framework of a chest of drawers, which is, in fact, nothing more than a set of very large pigeon-holes; but in order to save material and to render the article less weighty when completed, only just so much of the framing is inserted as may be absolutely necessary for the support and division of the drawers. For this reason the framework of the chest of drawers may be looked upon as being a set of *skeleton* pigeon-holes.

Framework of chest of drawers.

883. The reader will easily see how the interior framing of the case of a chest of drawers is made from fig. 450, from which the top has been removed in order to show as clearly as possible the general principles of construction. The illustration and the description, with

a few verbal alterations, are taken from "The Illustrated Carpenter and Builder," a work which is well worthy the attention of amateur workers in wood, and merits a place on their bookshelves. The sides and bottom of the case are of inch pine, about 18in. wide. The bottom is run into a V-shaped groove in the sides, as this affords continuous support to the edges on both sides and does away with the unsightly appearance that would be presented if it were mortised into the sides.

How frame-work is constructed.

Sides and bottom of case.

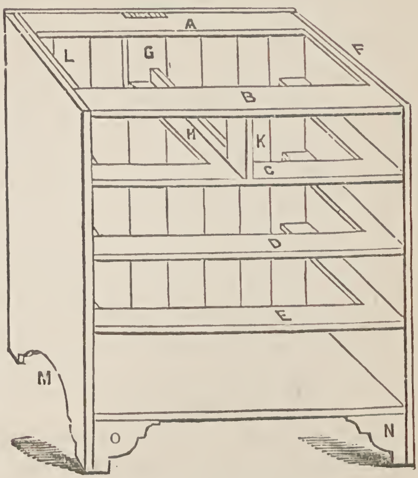


FIG. 450. FRAMEWORK OF CHEST OF DRAWERS.

The bottom should be blocked round below to impart additional strength to this part of the structure. The cross-pieces A and B are dovetailed into the top edges of the sides, and these serve as ties to hold the sides together at the top. The ledges C, D, and E are also mortised into the sides, but the ends of the tenons must not appear on the outer surface of the sides; and the ledges which run from each of these on each side to the back are also attached to the sides by screws after being glued to them. A piece of inch stuff, 3in. wide or a little more, is notched into the top rail A and the bottom, as shown at G. A horizontal ledge H is mortised into this upright and the horizontal rail C, to serve as a bearer for the sides of the small top drawers; and in order to keep them apart and in their places when being drawn out and pushed in, an upright K is mortised into B and C, and a vertical rail about 1in. or 1½in. deep screwed along the centre of H. The interior is now complete, and the back must be put on. This consists of alternate pieces of ½in. and ¾in. stuff, the edges of the thicker pieces being rebated so as to cover those of the thinner ones. Thus the surface of the back is flush within throughout, but without one piece projects beyond another. It is almost needless to remark that the two outside pieces that come against the sides should be thick pieces. The ends of these uprights are nailed

Cross-pieces.

Ledges in interior.

Back of drawers.

to the top rail A and the inner edge of the bottom, and the sides are nailed down to the thick pieces of the back on each side.

884. Lastly, a top is made of inch pine, flush with the thick pieces of the back behind, but projecting 1in. over the sides and front. It is screwed on to A, B, F, and L from the inside. It should have been pointed out that F and L are ledges screwed to the sides for this purpose, running from the top-rail B to the top-rail A. The sides are made in one piece throughout, and are cut out at the bottom, as shown at M. Pieces are then attached to the front at N and O, to give the appearance of dwarf legs, on which the chest of drawers seems to stand. A moulding is run round the top of the case in order to take off the harsh appearance of the sharp rectangular edge. Sometimes the bottom is moulded and projects slightly beyond the general plane of the front, and instead of dwarf legs or feet, as shown in the figure, the sides are not carried below the bottom, but blocks are screwed on to the bottom at each angle in which short turned legs or knobs are inserted. The fronts of the drawers should be made of inch wood, and the sides and back of ⅝in. stuff, ½in. stuff, or $\frac{7}{16}$in. being used for the bottom, which is run into grooves cut in the inner surface of the front and sides as already described in the section devoted to the construction of drawers. When finished, the chest of drawers, and indeed all articles of furniture made of pine, may be painted and grained, or stained and varnished, or French-polished.

Top of drawers.

Legs, etc.

Fronts of the drawers.

885. A cupboard is a space enclosed with doors and fitted with shelves or rails bearing pegs or hooks, according to the purpose for which it is used. A cupboard may be fixed or movable, that is to say, it may consist of a recess in a room which is covered in by a frame and doors hung within the frame; or it may be made with sides, bottom, top, and back, like the case or frame of a chest of drawers, having doors in front. It is manifestly impossible, as it is also unnecessary, to describe all the different positions in which cupboards may be constructed, or all the different articles of furniture which partake of the nature of cupboards; we shall therefore confine our descriptions to the method of fitting up a recess by the side of a fireplace as a cupboard, and the mode of making a small portable cupboard, and of making and fixing the old-fashioned but useful corner cupboard.

Cupboards, fixed or movable.

886. Let us suppose, first of all, that we are about to make a cupboard in the recess of a room already finished, and that in fig. 451 A B represents the line of the chimney breast, and B C D E the recess

that it is required to convert into a cupboard. There is a skirting round the room which must not be cut away, as our object is to remove the cupboard at some time or other, and to leave the recess and skirtings as unharmed as possible by our operations. The skirting will project beyond the face of the wall A B C D E at the bottom of the room, as shown by the lines, and the white space enclosed within, A B C D E, which, it should be said, represents the plan of the recess. Our first care is to make a frame with a door or doors hung within it, the frame being represented in section by the shaded parts L M. Part of the frame at M must be cut away so as to fit over the skirting at E, and to abut against the surface of the wall D E, but a slip of wood shown by the black block at B must be nailed to L on the inside to fill up the space that must intervene between L and the wall A B above the skirting against which the bottom part of the frame rests.

Cupboard in recess of room.

Treatment of skirting.

Frame for door or doors.

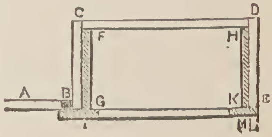


FIG. 451.
CUPBOARD IN RECESS.

It must be left to the option of the maker whether he will have a rail across the frame at the bottom; if not, he must take care to keep the sides in place by nailing a thin slip of wood across them, and keeping it there until the frame is fixed. The frame being ready and the doors hung within it, but removed temporarily until the frame is fixed, arrangements must now be made for fixing it. First nail two slips of wood, F G, H K, shaded in the figure, to the floor close against the skirting, and to the wall at the requisite height nail ledges, shown by the white spaces B C, C D, D E, to the surface of the wall. On these ledges the top of the cupboard may be laid and fastened down, supposing always that the cupboard does not reach to the top of the room. To this top the top rail of the frame is to be nailed, the bottom of each side butted against the skirting and slip F G on one side, and the slip H K on the other, being secured by skew-nailing to the floor. The frame and top are now complete, and the doors may be re-hung. If the recess is to be fitted up with shelves, ledges must be nailed to each side of the recess to support the shelves, but the amateur is already acquainted with the best methods of doing this and of putting up rails fitted with pegs or hooks.

Rail across frame.

Top of the cupboard.

Shelf or shelves within.

887. If a dwarf cupboard is to be made the same plan is to be pursued, but instead of the thinner top of inch stuff or even less, which may be used for the taller cupboard, a slab of 1¼ in. or 1½ in.

stuff should be inserted; or if thinner stuff be used, an appearance of thickness should be given to it by nailing on a strip of wood or a moulding to the edge of the slab. The slab should project beyond the surface of the frame and doors; but if a slip or moulding be nailed to the slab, the edge of the slab may be flush with the frame, etc., and the projection made by the slip or moulding which may be nailed to it.

Dwarf cupboard in recess.

888. We will now proceed to consider how a small portable cupboard may be made which, with various slight modifications, may be made available for a variety of purposes and situations. Such a cupboard is very closely allied to the cheffonier, and may be easily adapted to do duty as such. Without any further comment, it will be understood that this and all other articles of furniture which may be described in this chapter may be grained, or stained and varnished, or French-polished. The style in which the amateur may decide to finish his work must be left to himself.

Small portable cupboard.

889. The illustration which is now presented to the reader will speak for itself, and requires no description in detail as to *how* it is to be made. The sides are made flush throughout from top to bottom, and to these the panels and frames which form the doors are hung. The back is made in precisely the same way as the back of a chest of drawers, and the top, when a simple top like that of a chest of drawers is used, is

Example of portable cupboard and desk combined.

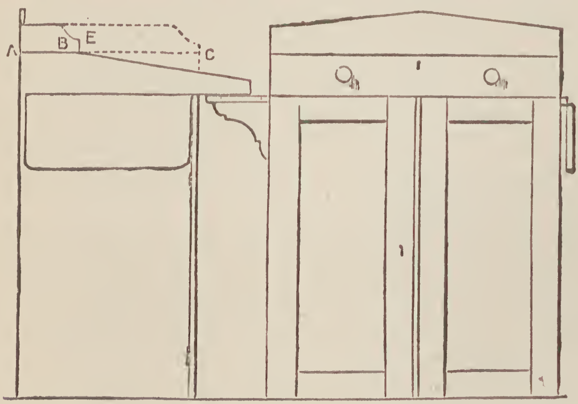


FIG. 452. SIDE ELEVATION. FIG. 453. FRONT ELEVATION.
SMALL PORTABLE CUPBOARD.

put on in a similar way. In some cases it may be convenient that the top of the cupboard should consist of a sloping desk with a ledge at

the back. This mode of construction is shown in the side elevation in fig. 452. To make the desk, ledges must be screwed to the sides and a rail mortised into them in front, against which the top of the cupboard may rest when closed, and on which the bottom of the cupboard may be dropped in. The sides of the cupboard may be carried high enough to form the sides of the desk, and a flat piece must be nailed across at B, to which the lid of the desk must be attached with hinges; but in this case allowance must be made at the top for the projection of the desk beyond the cupboard front. If, on the other hand, it is not desired to cap the cupboard with a desk, the sides should be carried up square, as shown by the dotted line A C, so that a drawer may be put at the top instead of the desk, and a ledge carried round the top to prevent anything from being knocked or pushed off the slab at top; but in the case of the desk the sides of the ledge will only reach as far as the beginning of the slope. The brackets at the sides, as shown in both figures, form a useful addition to the cupboard, especially in a small room.

Desk to project beyond cupboard.

890. The old-fashioned three-cornered cupboard for the corners of rooms is now very seldom seen in any but old farmhouses and cottages. Its modern representative consists of three shelves, decreasing in size from the lowest to the highest, set in side pieces which fit against the walls of the room, and are adorned with fret-work. The cupboard in this form is little more than a bracket in three tiers, and it is suitable for nothing else than a stand for china and other curiosities of value. There are many places, however, in which a corner cupboard shut in by a door, and thus rendered a receptacle in which articles can be kept under lock and key, will be found not only useful but appropriate, and for this reason some remarks are now added on its general construction and the method of fixing it.

Old-fashioned three-cornered cupboards.

891. For all practical purposes, the plan of the three-cornered cupboard given in fig. 454 will be sufficient to show the amateur the general principles of construction of articles of this kind. A B and B C are the sides of the cupboard, which must be dovetailed together at right angles, so as to fit against the walls that meet and form the corner of the room. The common method of procedure is to bevel off the edges of these sides at an angle of 45°, and fit against them a frame shown by the double dotted lines A F and G C. To this frame the door F G is hung. Now it is clear that when a corner cupboard is made in this way its

Construction of three-cornered cupboard.

capacity for holding articles, such as cups, jars, etc., is very limited; the corners at F and G being almost useless. The holding capacity of the cupboard may be increased without increasing the size of the sides, by dovetailing or otherwise fixing sides, as shown at A D and C E at right angles to the main sides A B, B C. The sides A D and D C will serve as the frame for the door, which may be hung to either of these side-pieces as may be most convenient. In the figure the door D E is shown as being hung to C E by hinges as at E. Whichever way the cupboard may be made, there is no necessity for stops inside, as the edges of the shelves will furnish stops to stay the inward progress of the door. To receive the shelves, ledges as at F H and H G should be screwed to the interior of the sides A B and B C. When the cupboard is made with a projecting front, as indicated by A D, E C, the corners at A and C are rendered useful. With regard to other details—which would appear in a drawing of the elevation, but which is not given, as the amateur will be capable of working this out on paper for himself—according to plan No. 1, the top and bottom should be added to the sides first of all, and the frame in which the door is hung made to cover the whole, and be flush with the outer surfaces of both top and bottom. According to plan No. 2, in which the cupboard is made of greater capacity, the bottom of the cupboard may be brought beyond the lines A D, D E, E C, as shown by the outer dotted line, and neatly rounded off in the form of a bead. The top, in this case, may also be nailed on over the door, but flush with it, and not going beyond it; and a ledge may be screwed firmly to the upper surface of the top, flush with the edge that appears over the door, in order to carry a neat moulding or crestboard, which will impart an appropriate finish to the top. This may be ornamented according to the taste of the maker.

To increase holding capacity.

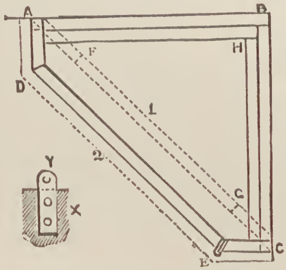


FIG. 454. PLAN OF THREE-CORNERED CUPBOARD.

892. To support the cupboard, ledges should be nailed to the wall in the same manner as for the support of the shelves within the cupboard at F H and H G, and to these a rail may be mortised, running from the outer end of one ledge to the outer end of the other, forming with them a skeleton shelf on which the cupboard may rest. To keep the top of the cupboard close against the wall, two pieces of iron, as shown at X, may be screwed to

Cupboard, how supported.

the sides A B and B C, and a brass-headed nail driven through the hole Y in the top of each iron.

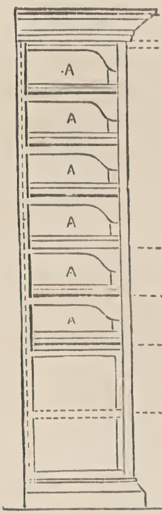
The wardrobe.

893. The wardrobe may be described as a combination of the cupboard and chest of drawers, as most wardrobes are made with a cupboard at top, and a deep drawer below which is sometimes made available for holding hats and bonnets. It is not likely that the amateur will ever go so far in joinery as to construct a wardrobe; he will, in all probability, be content with fitting up a recess in a bedroom as a hanging closet, in the manner already described; but as there is no knowing what a man may be led

General arrangement.

to do who has plenty of time on his hands, the elevation, section, and details of construction of a very useful wardrobe are given below. The plan of this wardrobe and the accompanying illustrations have been taken from the pages of the "Illustrated

Fig. 458. section of doors.



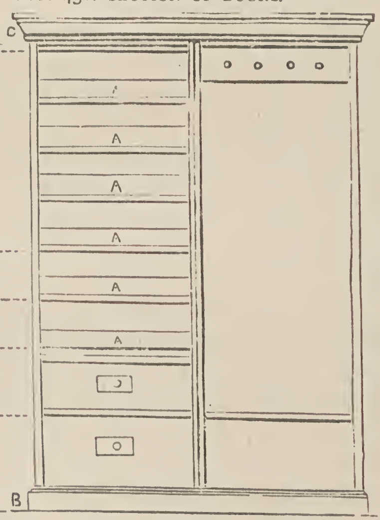


Fig. 457. transverse section.

Fig. 455. front elevation.

Fig. 456. elevation of door.

WARDROBE.

Carpenter and Builder," a most useful serial publication, which we have already recommended to the attention of all amateur carpenters and builders.

894. The body of this wardrobe, as will be seen from an examination of fig. 455, must be made in two parts, with the cornice above

and the plinth below separate. Suitable proportions for such a wardrobe as this are 7ft. high, including plinth and cornice, and 4ft. 6in. wide. Its depth should be 18in., without the doors. Allowing 4in. for the plinth and the same for the cornice, the size of the parts or carcases in which the wardrobe is made is 6ft. 4in. by 2ft. 3in. The back edge of the frame of each part must be rebated to allow of a ⅞in. framed back, or a back may be put in as already described for a chest of drawers. The sides of the frame should be made of 1¼in. stuff, well planed down. In the part to the right hand is a hanging cupboard at the top, with a rail for pins or hooks for hanging clothes. At the bottom is a deep box for hats and bonnets. The front of this box is a fixture, and the top slides in and out. The part to the left hand is made to contain six trays above for clothes, etc., which pull in and out, and two drawers below, the lower drawer being of the same depth as the bonnet-box in the right-hand compartment. The construction of the left-hand compartment is shown in section in fig. 457. The trays A, A, etc., run in grooves made in the sides of the compartment in which they are placed; they are 1in. apart, and are about 6½in. deep, with 3in. fronts. They have very much the appearance of six small butlers' trays fitted in one above another. As there is the depth of 1in. between the trays, the amateur will find it easier to screw ⅞in. ledges on to the sides of the compartment, on which the trays may run, instead of ploughing grooves in the sides of the compartment and making the bottom of each tray to fit the grooves. The drawers at the bottom are 8in. and 10in. in depth respectively, and as the depth of the lower drawer and hat-box correspond, the latter in the right-hand compartment must also be 10in. deep.

Proportions of wardrobe.

Thickness of timber used.

Box for bonnets, etc.

Compartment with trays.

Drawers at bottom.

895. When the two compartments are finished, the plinth B is framed so that the compartments may drop within it, and a moulding C placed round the top. The plinth must be made broader than the compartment to allow for the doors, which must open and shut just clear of the moulding and over a slip of wood which is nailed to the top edge of the plinth, *within* the moulding and flush with the top of the moulding. When the compartments have been placed side by side of the plinth, two or three screws may be driven through the inner side of one compartment into the adjacent side of the other to keep them firmly together.

Plinth.

Connection of body and plinth.

896. One of the doors for the compartments is shown in fig. 456.

A frame is made to receive a circular-headed panel. The wood used for the frame should be 1¼in. thick when planed down, and the hanging style should be 4½in. wide, and the falling style 2½in. wide. The manner in which the panels are inserted and the bolection moulding put on is shown in fig. 458, which represents a transverse section of the doors. At D, the line in which the doors meet, a semicircular bead is attached to one door and laps over the other, to hide the line of junction when the doors are closed. The doors are hung to the outer side of each compartment. The panels, if desired, may be filled with silvered glass so as to form a mirror, which will serve as a cheval glass. In this case, a strong panel must be put in behind the glass. For the cornice a frame is made similar to the plinth, but flush with the sides and projecting only in front. A moulding is nailed on to the edge of the frame, which drops slightly over the top of the compartments. The door is made to work clear of the moulding, the space between the moulding and the frame being filled up, as in the plinth, with a small piece of wood of the necessary thickness. If made of deal the wardrobe should be stained and varnished or French-polished.

Doors for compartments.

Glazed panels.

897. Few kitchens will be found without a dresser, which, in point of fact, is a fixture almost as requisite to the house as doors or stairs. The amateur will, in all probability, be never called upon to make one; but the requirements of his family may render it desirable that a recess in a kitchen, or indeed in a back kitchen or scullery, be fitted up by way of additional accommodation. To this end a brief description of the kitchen dresser, and the way in which it is made may prove desirable to some of our readers.

Kitchen dresser.

898. The general construction of the kitchen dresser is shown in section in fig. 459. A solid slab of deal, about 1½in. thick, is made to form the dresser-board or principal shelf of the dresser, as shown at A. This slab is supported at either side by two solid ends, which, in their turn, are framed into a plinth G, which consists of a platform made of boards nailed on runners. The ends of the dresser are mortised into the outer runners on each side, and the boards forming the platform are nailed to these and to two or more cross-pieces, framed into longitudinal pieces of the same thickness at front and back. To the broad

Construction of dresser.

Slab for dresser-board.

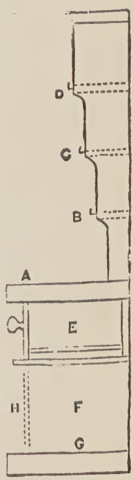


FIG. 459. KITCHEN DRESSER.

frame thus made it is desirable to form a back with match-boarding or with boards, put on as in the chest of drawers—that is to say, thick and thin boards in alternation, the edges of the thicker boards being rebated so as to fit over the thinner ones. A slip of wood must be nailed in front of the framing of the platform below, to conceal from view the space underneath. Along the front of the dresser a frame is inserted to receive two or three drawers, as shown at E, and under that part of the frame which divides any two of the drawers, whether they be two or three in number, it is desirable to put uprights, as shown by the dotted lines at H, to help support the thick slab at A, and to prevent it from sagging in the middle from its own weight, which is often the case with large and long dressers. The framing on which the drawers run is made in precisely the same way as that which receives the two small top drawers in a chest of drawers. The space F below the drawers may be enclosed with doors or left open, as may be thought desirable. When left open the platform is painted black, and constitutes a "pot-board" on which saucepans, kettles, etc., are placed when not in use.

Back of dresser.

Drawers in front.

Pot-board.

899. On each side of the slab A, and on the inner part, two uprights of the shape shown in the illustration are mortised, and into these are mortised shelves, the lower shelf in every case being narrower than the one immediately above it, as shown at B, C, and D. Ledges are nailed along the upper surface of these shelves and along the slab A to support plates and dishes, and hooks are screwed into the front edge on which jugs and mugs are suspended. These dresser-hooks, as they are called, vary from 1s. to 1s. 6d. per dozen, according to size.

Uprights for shelves.

Ledges, why nailed on shelves.

Hooks for jugs, etc.

900. The lowest shelf in the dresser, which is formed in reality by the inner part of the slab A, is reserved for cheese-plates; the shelf B for pudding-plates, C for dinner-plates, and D for large dishes. When soup-plates are frequently used, and the family is a large one, it is as well to have, if possible, an extra shelf for soup-plates between C and D. The dresser is finished with a cornice and moulding above. That it is desirable to make the sides of the dresser so that the higher a shelf is the further it projects, is manifest from the fact that the jugs which are placed on the hooks fixed to the higher shelves hang out clear of those on the shelves below, and can be easily reached and removed without touching any of those beneath them. The space

Appropriation of shelves.

How sides of dresser should be made.

behind the shelves may be filled with match-boarding or left open, according to the will of the maker; it is better, however, to fill up with match-boarding, which, when painted, can be washed when necessary, while a coloured wall cannot be cleansed in this manner.

Space behind shelves.

901. From drawers, wardrobes, and dressers we must pass on to bookshelves, which the amateur carpenter will be more likely to make for himself than any of the pieces of furniture which have just been enumerated. Bookshelves, in fact, may be made out of almost anything. Out of some boards that had once formed an egg-box the writer has made a small set of bookshelves with plinth and cornice, which is still in use, and which, when it was stained and varnished, betrayed no traces of its origin. We will begin by giving instructions for making a set of shelves of this kind, and then proceed to others of more elaborate construction and superior finish.

Book-shelves.

May be made of simple materials.

902. The method of making a small set of bookshelves out of egg-box boards may be gathered from the annexed diagrams, of which fig. 460 represents the elevation, and fig. 461 the section and end of the shelves. First of all, four nice clean pieces of board must be selected for the top, bottom, and sides, and these must be nailed or dovetailed together as may best suit the amateur. The boards used in making egg-boxes are as a general rule thin, and it will be better to dovetail the parts together. Before the tenons and mortises are glued up and otherwise secured, ledges as shown by the lower dotted lines at A, B, and C, must be screwed to the sides on the inner surface to support the ends of the shelves. The frame may then be put together, and the shelves, which must be flush with the edges of the frame before and behind, can be slipped into their places, and secured by brads through the sides just above the ledges.

Book-shelves of boards of egg-boxes.

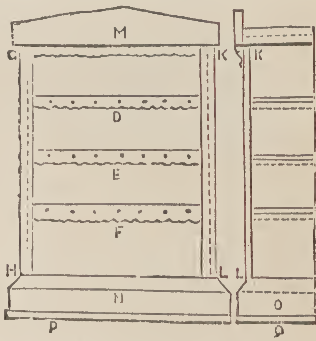


FIG. 460. ELEVATION. FIG. 461. SECTION.
SMALL BOOKSHELVES.

903. In order to do away with the thin and unsubstantial appearance presented by the edges of the sides, and to hide the ends of the side ledges, strips of wood about 1in. in width, as shown at G H and K L, are nailed to the edges of the

To make thin boards look substantial.

sides, which come as far as the dotted line drawn along the middle of the slips. After this is done it will be as well to nail thick ledges of wood to the outer surfaces of the top and bottom, to serve as foundations for the cornice M and the plinth N. The cornice is formed of a piece, shaped as drawn, in front, and two side-pieces. These parts project beyond the top of the shelves all round. Before the piece M is put on, the strip of leather that appears below it should be nailed to its inner surface. This leather must be exactly as long and no longer than the distance between the inner edges of the strips G H, K L, so as to work in and out freely between them ; and when the shelves are completed strips of the same length should be nailed to the edges of the shelves at A, B, and C, as shown in fig. 460 in D, E, and F. Finally, round the bottom, and having the upper edges flush with the surface of the bottom of the frame which forms the lowermost shelf, pieces of wood, bevelled above as shown in the drawings at N and O, should be nailed to the ledges attached to the bottom to form the plinth, which may, if the amateur approve of it, have a half-inch bead bradded on round the bottom as at P and Q. If the lower board of the frame which forms the lowest shelf has not been brought out far enough to be flush with the slips G H, K L, these slips being dropped into notches cut in the board to receive them, the opening between the edge of the shelf and the top of the plinth must be filled up neatly and closely with a slip of wood of the proper size. The sides and front of the shelves may then be stained and varnished. The appearance of the shelves is much improved by the addition of two small brackets at G and K, which seem to support the overhanging cornice or crest-board at M.

Formation of cornice.

Leather strips on shelves.

Brackets under moulding.

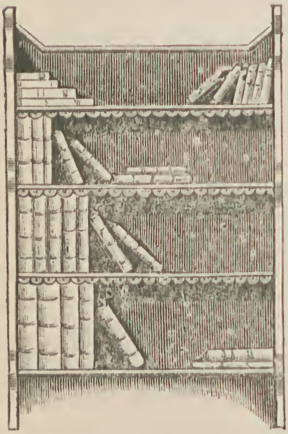


FIG. 462. HANGING BOOK-SHELVES.

904. A pretty design for a somewhat similar set of shelves, without cornice and plinth, and intended to be fixed against the wall, is shown in fig. 462, which is drawn on a scale of ¾ in. to a foot. The shelves are grooved into the sides and back, and glued up and nailed. The sides may be stop-chamfered. These shelves are suitable for hanging-shelves in a recess, but it is advisable to make them the width of the

Good designs for book-shelves.

recess, or if not, to place brackets in the form of quarter circles against the sides in the same plane with each shelf for the reception of jars and pieces of china of a suitable height. Another design for a hanging bookshelf is shown in figs. 463, 464, which represent the front and side elevation. The cornice and base in fretwork, and the carving in relief in a sunken panel on the side, add very much to the appearance of the shelves. Instead of showing the edges of the sides in front as shown in fig. 463, the frames of the doors may be made of narrower stuff, and hung to the sides, hiding them from view altogether, and the panels may be of glass instead of wood.

905. Any of the bookshelves already described may be adapted with a little contrivance to form shelves on the top of a dwarf cupboard, which should be made to suit the style of the shelves. In the first kind the plinth should be omitted altogether, and the bottom of the framing that holds the shelves be allowed to rest on the top of the cupboard, or the sides be extended downwards and mortised into the slab that forms the top of the cupboard. In the second and third examples the sides may be extended downwards, and also mortised into the top of the cupboard, a mode of arrangement which provides for the retention of all the ornamental work that is shown in the illustrations. In each of these the most appropriate way of extending the sides is to carry them downwards in the form of a bold bracket sweeping outwards, and wider at the bottom than at the top where the shelves commence. The extension thus made may be pierced with fret-work or carved in low relief, in accordance with the general character of the ornamentation of the shelves.

Shelves on dwarf cupboards.

FIG. 463. FRONT ELEVATION. FIG. 464. SIDE ELEVATION.
HANGING BOOKSHELVES.

Extension of sides.

906. We will now examine a simple but effectual method of making bookcases or bookshelves that will be found particularly useful to the amateur, inasmuch as the shelves thus formed can be added to or

diminished at pleasure, and adapted to any kind of room or recess, no matter what its size may be. Being made in deal, stained and varnished or French-polished, the cost is but little for shelves that cover a considerable expanse of wall; and as their construction is but very simple, they are such that any amateur may make for himself, even though he be not able to use his tools as well as he could wish.

Simple and useful bookshelves.

907. In the accompanying illustration fig. 465 shows the front elevation of a compartment of such a bookcase, and fig. 466 the section and inner part of each end piece as well. These end pieces, and indeed all the standards that divide the bookshelves into compartments, should be made of good straight-grained pine, ¾ in. in thickness after it has been planed down; and if the shelves be large and cover a considerable area of wall it will be as well to have them 1 in. in thickness. There must be *two* end pieces, but the standards between these may be as few or as many as necessary. In a long extent of shelving the distances between each pair of standards should not be less than 2ft. or more than 3ft. First taking the structure of an end piece, which may be of any height, though 6ft. will be found convenient, one side must of course be left perfectly plain, but on the other and inner side, A A, as shown in fig. 466, a stout ledge about 1 in. square should be screwed on at B, and strips along both edges, notched, as at C, C, for the reception of slides on which the ends of the shelves may rest. This is shown on a larger scale in fig. 467, in which C, C are the notched slips, D the slide, and E the superincumbent shelf, all in section. The standards and the other end piece are made of precisely the same size, and in exactly the same manner as the first end piece, only in the second and opposite end piece the ledges and notched strips must be screwed on to the reverse

How to construct them.

Made in compartments.

Fig. 465. FRONT ELEVATION OF COMPARTMENTS.

Fig. 466. INSIDE OF END PIECE, ETC.

Structure of end pieces.

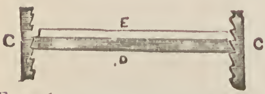


Fig. 467. SUPPORT FOR SHELF IN END PIECE, ETC.

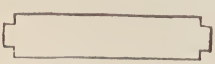


Fig. 468. PLAN OF SHELF SHOWING NOTCHES AT CORNERS.

Standards between end pieces.

side, so that the parts of the ends thus prepared may be inwards and facing each other when the ends and standards are placed in position; and in the standards the ledges and notched strips are attached on both sides instead of on one side only as in the end pieces.

908. When the standards and end pieces have been placed in position at such distances from each other as may have been previously determined, a board E is laid along the top from end to end, and nailed or screwed—screwing is better, in case of removal and taking the bookcase to pieces at any time—to all the uprights.

How to put parts together.

Additional firmness is obtained by means of a narrow board F, which is screwed to the end pieces and standards all along the front.

Board at top.

To this a moulding G is attached above, and the cornice consisting of this moulding and the facia F is apparently supported by little carved brackets H, attached to the end pieces and standards. The moulding G and the brackets H are clearly shown in the side elevation of the bookcase represented in fig. 466.

Cornice and brackets.

Along the bottom a board K, about 15in. in width, is attached to the end pieces and standards along the entire length; and for the sake of rendering the bookcase substantial in appearance, another narrower board L is screwed on in front; the two boards, with the moulding or bead M which is placed along the top of K, forming a bold and handsome-looking plinth to the whole bookcase.

Bottom of bookcase.

The chief use of M is to mask the outer edge of the board N, which—as, indeed, are all the other shelves—is cut, as shown in fig. 466, to drop in upon the edges as shown at B, and form a shelf or platform to receive the lowest row of books, which will comprise the longest and heaviest among them. As this shelf can be removed at pleasure when all the books upon it are taken out, the open space A below it affords a convenient place for stowing away unbound periodicals, rolls of maps and engravings, and the thousand and one odd matters for which it is desirable to find a hiding-place and which are usually put in the cupboards of the bookcase when it is made with cupboards below and shelves above.

Uses of space below bottom shelves.

The shelves are finished in front with scalloped strips of American leather-cloth, or embossed edging, which may be let into the under part of the shelf close to the front edge with a tongue and groove, or nailed along the edge with gilt-headed nails or white studs.

The shelves and how to finish them.

909. It will be obvious to all that the standards and ends will serve in any case, and that when it is necessary to extend the bookcase and

add to its length, to accommodate an increasing stock of books, all that is necessary is to carry one end further on, to interpose a new standard, and to have new boards for the top, the facia, and the plinth. If it is needful to curtail the length of the bookcase, it is merely necessary to take out a standard and reduce the boards that have just been named to the required extent. When, as may be the case in moving from one house to another, it is necessary to reduce or extend the length of the bookcase by a few inches only, it may be managed by bringing the standards a little closer together and shortening the shelves; or by increasing the distance between any pair of standards—the central compartment or compartments being the most suitable—and having new shelves for the space or spaces thus extended. Anything may be done with a bookcase of this kind. It is almost needless to remark that it is always prudent to preserve old facias, plinth-boards, and shelves that have been replaced by others, as they may be found useful on another occasion. If it is desired to have glass doors to a bookcase of this kind, the notched strips should be placed farther in, and the doors made so as to be hung to the ends or standards, their outer surface being flush with the outer part or edges of the ends and standards. When the bookcase is a fixture doors are desirable for the purpose of keeping out dust, but when *elasticity* in the bookcase is desirable it should be made without doors as described.

Bookcase on this principle may be extended or diminished.

Doors not recommended.

910. An American writer has suggested a very simple and ingenious method of making a bookcase on the expansive principle, and doing away with the necessity of packing and unpacking books on removal from one house to another. The plan, which is as follows, is well worth the attention of the amateur.

American bookcase on expansive principle.

911. "The cheapest," the inventor says, "is also in some respects the best bookcase. This is a box, or case of boxes, of indeterminate number. The box is about 4ft. long and 20in. high, inside measurement. A shelf runs from end to end, dividing it into two sections, each, therefore, being about 9½in. high. Three or four of these boxes, placed one above the other, make a case five to seven feet high. An unostentatious base-board (plinth) below, and a moulding (cornice) above, will help to make it ornamental. If the two upper boxes are made a little narrower, and not quite so high, the bookcase presents a graduated appearance, which is, perhaps, an advantage.

Plan of construction.

This mode suitable for those who change houses often.

If you are a tenant, and have occasion to move, you have only to turn your boxes over on the back, without even taking the books out, stuff paper or cloth about them, screw a board on the upper surface, and they are packed."

912. The amateur carpenter who is fond of his books, and can manage to appropriate a small room to himself as a sanctum or study, can now see how easily he may make for himself every atom of furniture within it except his chair, which he will do well to purchase, selecting a library chair with a wooden seat, which will cost from 12s. 6d. to 15s. To the above description we need only add that the plinth should be made in the same manner as that which has been described for the wardrobe, but higher, in order to keep the lowest row of books out of the way of sweeping brooms, etc. The cornice also should be made in a separate piece, and drop over the topmost box. It is also advisable that some method should be adopted of connecting the boxes when piled one above another. This may be easily effected by a bead from top to bottom along the edge of each side which shows in front, or by slips also running from top to bottom at the back or sides. These, of course, must be unscrewed before the boxes are taken down for removal. As a finish to the shelves, leather edging with scalloped edges, or strips of American leather-cloth, should be attached to the shelves.

Furniture for book-room may be made by amateur.

Leather-cloth on edges of shelves.

913. Here we may bring to a close our remarks on the construction of household furniture which partakes of the box form. From what has been said in the foregoing pages the amateur will doubtless find the way to make other useful things which are similar in principles of construction, and which, by reason of this very similarity, need no mention here.

CHAPTER IX.

COMBINED CHAIR AND HOUSE-STEPS : PICTURE-FRAMES : FLOWER-STANDS AND STAGES : GLAZED WINDOW-BOX : FOUNTAIN : SWINGS.

Miscellaneous Articles—Combined Chair and House-steps—Principles of Construction—Construction of lower portion—Mode of making upper part—Parts connected by Hinges—Frames for Pictures—Where to obtain Materials—Mouldings for Frames—Appropriate styles for different Pictures—Mounts for Pictures—Prices of Mouldings—Tools requisite for making Picture-frames—Mitring the Corners—Picture-frame Maker's first care—Mitre-box necessary—How Mitre-box is made—How to put Frame together—Contrivance for holding pieces—Suggested improvements—Clamps for board—"Oxford" Frames : their peculiarity—Materials for making them—Principles of Construction—Simple way of making Rebate—Flower-stands and Stages—The ordinary Flower-stage—Simple mode of Construction—Width of Shelves for Plants—Easy Stage for Amateur—Stage with Brackets for Rails—Stages of various forms—Rectangular Stand—Semicircular Stand—Flower-stands for Windows—Flower-stand of Wood and Wire—Pillar—Supports for Shelves—Wire Edging : how to make it—Flower-stand for Bow Window—Mode of Construction—Zinc Cases for Plants—Staining and Varnishing most suitable for Flower-stands—Hanging-baskets—Modes of making Hanging-baskets—Glazed Window Box—General form of Window-box—Bottom and sides—Front and roof—Access to Box : how obtained—Fountain in Garden—Principles on which they act—Construction and action exemplified—Inexhaustible Fountain—Swings : danger arising from their use—Swing for little children—How to put up a Swing—The Uprights—Hooks and Ropes.

914. THERE are various articles that require brief notice that cannot be included in any of the groups that have been treated in preceding chapters on account of peculiarities in construction that are not found in those which have been described. **Miscellaneous articles.** Among these are that useful compound piece of furniture which forms a chair for the hall or lobby, or a small set of house-steps, as may be found convenient by the owner ; picture-frames, including those of the ordinary kind and those known as "Oxford" frames ; flower-stands and stages for indoors and out of doors, and the glazed window-box. Each and all of these will find a place in the present chapter, in which we will also take occasion to include some remarks on fountains,

suitable for gardens, rock work, conservatories, etc., and swings, which are always acceptable to children.

915. First of all let us take the combined chair and house-steps. The method to be followed in making house-steps with a frame hinged to them behind so as to spread out from the steps, and help in forming a broad and stable base, has been described elsewhere in "Every Man his own Mechanic," and the amateur has also been shown how to make a ladder. Light ladders are sometimes required for use within doors, and as these are sometimes placed against bookshelves, windows, etc., to guard against any injury from the ends of the side pieces, a piece of wood about 18in. long, and from 3in. to 4in. wide, should be attached to them at the top of the ladder, as a long shield running from side-rail to side-rail in a horizontal direction, and extending some inches beyond them on either side.

Combined chair and house-steps.

916. The construction of the combined house-steps and chair is clearly shown in fig. 469, and any skilful amateur may make this piece of furniture for himself by the aid of the diagram. It will first be necessary to note that the step-chair is formed in two parts, and that the dimensions of each part must be carefully studied in relation to the other, so that the contrivance may work properly when made. Let us now look to the construction of the lower portion, which forms the whole base of the chair, but only part of the base of the steps. All the stuff used for this step-chair should be good deal or pine, 1in. in thickness, but thinner stuff may be used for the rails, whether they are simply screwed into the uprights that form the chair back and long legs of the steps, as shown in the drawing, or mortised into them, which will be found more convenient. Two pieces of wood 15in. long and 4½in. wide must first be planed up; these will serve,

Principles of construction.

Construction of lower portion.

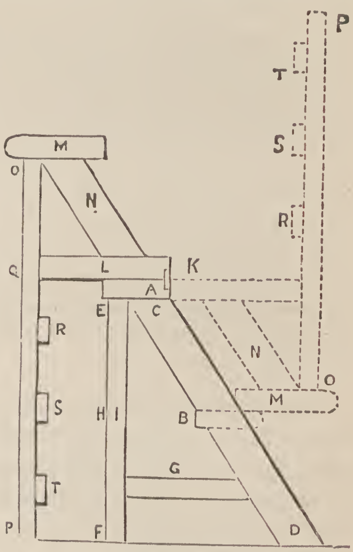


FIG. 469. COMBINED HOUSE-STEPS AND CHAIR.

one for the front part of the seat of the chair as shown at A, and the other for the lowest step of the steps as shown at B. Of these pieces B is notched and mortised at the ends, so as to receive and project slightly beyond the side-rail C D, which is 18in. long and 2½in. wide. The upper end C of each side rail is mortised into A, which also receives the end E of the leg E F, which, with its fellow at the other end of A, supports the front of the chair. The side rails and uprights are connected by horizontal rails as shown at G, and it will add to the strength of the frame if a cross-rail be placed between the uprights at H. The lower part of the structure is now complete, and it remains to make the upper part, which, when finished, is attached to the lower part by strong butt-hinges as shown at K. To make this upper part, two pieces of wood, L and M, must be planed up. Both of these must be 15in. in length, but L must be 9in. and M 6in. wide. L is notched to receive at Q the upright O P, which is mortised into M at O. The pieces L and M are further connected by a side-rail N, which must be cut rather more than 9in. long to allow for tenons, and the upright O P and its fellow are further connected and strengthened by cross-rails R, S, T, which, as it has been said, may be simply screwed to them or mortised into them. The upper part turns on and over the lower part by means of the hinges by which the boards A and L are connected. When the upper part is turned over the lower part so as to form a set of steps, the board L forms the second step, and M the upper step; when it is turned back so as to form a chair the board L forms the remainder of the seat of the chair, while the board M turns on to and rests on B, giving additional strength and solidity to the chair when the structure is used as such. The position of all parts of the upper part of the steps when turned so as to form the back of the chair is clearly indicated by the dotted lines, which are lettered to correspond with the various parts of the top, as shown by the solid lines to the right of the figure. When finished the step-chair should be stained of a light or dark colour, according to the taste of the maker, and varnished.

Mode of making upper part.

Parts connected by hinges.

917. It will be difficult for the amateur to find any more pleasing or profitable kind of work for internal decoration than picture-frame making; pleasing, because good results may be speedily obtained at little cost and with a small amount of labour; and profitable, because pictures, of whatever kind they are, whether engravings, chromo-lithographs, oleographs, water-colour drawings, or oil paintings, as long as they are good, form wall decora-

Frames for pictures.

tions of which the eye never grows weary, and in which some fresh attraction is always to be found.

Where to obtain materials.

Mouldings for frames.

918. In writing about picture-frames it will be necessary to mention the materials of which they are made, and the method of making them. The amateur can always purchase mouldings of any kind ready to his hand, and all that remains for him to do is to cut them into pieces of suitable length, and put them together. The mouldings can be bought of MR. GEORGE REES, *Picture Frame Maker, Strand, London, W.C.*, who has also a large stock of good and cheap pictures of all kinds, well worthy the inspection of the amateur. They may also be obtained of most paperhangers and decorators in the suburbs of London and country towns who turn their attention to frame-making as well as to the other branches of their crafts.

Appropriate styles for different pictures.

"Mounts" for pictures.

Pieces of mouldings.

919. Before going into the method of cutting out the pieces for picture-frames and putting them together, it may be well to point out to the amateur that, for engravings, mouldings of maple, oak, etc., with a slight gold bead within the polished wood, are more suitable; while for coloured pictures, no matter what they are, gilt mouldings should be used. For water-colour drawings, and prints and chromo-lithographs in imitation of water-colour drawings, a slight moulding is sufficient, and the picture itself is improved by being placed within a wide "mount," as it is technically called; that is to say, a large piece of cardboard of some thickness, with a piece cut out of the middle so as to show the picture, and having the edges bevelled and gilt. A gilt line is sometimes run round the mount, about ½in. from the bevelled edge. Oleographs, which are imitations of oil paintings, and oil paintings themselves, should be strained on a frame—if, in the case of oil paintings, they are painted on canvas, and not on a panel or prepared millboard—which fits into the rebate of the gilt frame. The amateur will find it difficult to cut a mount for himself, but these can be procured at various prices according to size from the print-seller or the mount-cutter. The glass may be obtained from the printseller, painter and glazier, or oil and colour-man. The prices of mouldings, in plain wood for engravings, and gilt in various widths for oil paintings may be obtained from the sources indicated above. The variety of mouldings is so great that it would occupy far more space than can be well spared to give a list of them with the description and price of each. It will suffice to say that they are sold by the foot, and that they range in price from

3d. per foot upwards, according to the width and ornamentation of the moulding. German mouldings are cheaper than English mouldings, and as handsome in appearance, but the latter have the merit of being more durable and not so liable to tarnish.

920. For making his picture-frames the amateur will require a fine tenon-saw, a mitre-box, and a clamp for keeping the corners of the frame in position while he is engaged in nailing them together. If he has not the first-named tool in a small size, that is to say from 6in. to 8in. in length, he should provide himself with one. A mitre-box, better fitted for the purpose than the mitre-boxes used by joiners and carpenters for ordinary work, he may easily make for himself; and a clamp, or contrivance to act as a clamp, for keeping the parts of the frame in position while being glued and bradded together, may be made with as little difficulty.

Tools requisite for making picture-frames.

921. To mitre the corners of a frame together, the moulding of which the frame is made must of necessity be cut at an angle of 45°. For

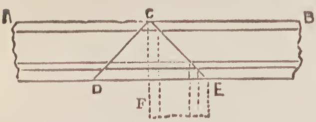


FIG. 470. MITRING CORNER.

example, suppose that A B is a piece of moulding: it is manifest that in order that the piece A C D may meet and fit at right angles to the piece B C E, as shown by the dotted lines at C F E, the moulding must be cut through in the lines C D and C E, which are at an angle of 45° to A C and B C respectively, or to the dotted line C F, which divides the right angle D C E into two equal angles D C F, E C F, each of 45°. The portion D C E having been cut away along the straight lines C D, C E, and the right-angled triangle D C E having been removed, the piece of moulding A C D will fit truly and accurately against the piece B C E—every line, projection, or depression in one piece meeting and fitting exactly to every similar line, projection, or depression in the other piece. From this it is evident that the picture-frame maker's first care must be—

Mitring the corners.

Picture-frame maker's first care.

To cut the pieces of which his frame is to be made and plane the ends up at a bevel which shall insure exactness in mitring when the pieces are brought together at the corners of the frame.

922. To do this with the precision that is necessary, a mitre-box must be provided. The ordinary mitre-box will be sufficient for the experienced professional maker, but for the amateur's use one of a somewhat different structure is desirable, that

Mitre-box necessary.

will serve as well for planing up the ends as for cutting them. Such a mitre-box is shown in fig. 471. This mitre-box is made of two pieces of sound straight-grained deal, each being about 1¼in. thick, 9in. wide, and 2ft. long. These pieces of board are firmly screwed together, the edge of the upper piece being set back 4½in. from the edge of the lower piece, as shown in fig. 471, in which the edge A B of the top piece is set back 4½in. from the edge C D of the under piece, and also in fig. 472, which represents a section of the two boards screwed together. By this arrangement a rebate is formed in which a trying-plane may be pushed backwards and forwards as may be necessary.

How mitre-box is made.

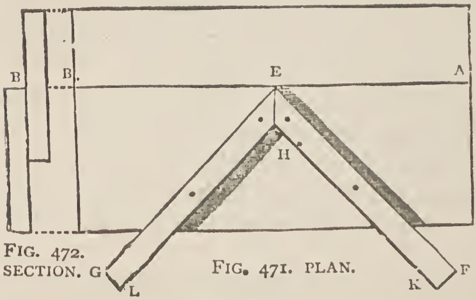


FIG. 472. SECTION. FIG. 471. PLAN.

MITRE-BOX.

Next, take two pieces of wood about 2in. in width, 1½in. in thickness at the least, and 12in. long; cut them at one end accurately to an angle of 45°, so that they may meet together in the line E H, which is at right angles to the line A B. Now it is clear that if the ends of the two pieces are planed up and brought just so close together in the line E H that a saw blade will pass between them and no more, if a piece of moulding be laid along the edge E F or E G, and cut, the edge of the saw passing through E H as a guide line, the end will be cut at the proper bevel. This may also be done if the square end of a piece of moulding be laid in the angle or corner at H, the moulding resting against the edge H K or H L. But this will only answer when it is necessary to cut a *square* end: in all other cases the moulding must be laid against the edge E C or E F accordingly. It should be held in position against E G or E F by one or two small clamps, which will save the amateur the trouble of holding the moulding when cutting it, and insure better, neater, and truer work. So far for the cutting. To plane up the bevelled ends of the pieces of moulding, all that is necessary is to lay each piece against the edge E F or E G, as may be necessary, with the bevel parallel to, and indeed almost coincident with, the edge A B, and then pass the trying-plane along the rebate against the edge A B until the end is sufficiently planed down. The iron of the trying-plane should be ground thin and well sharpened on an oil-stone.

923. The above ingenious mitre-box for frame-making was suggested by a contributor to the "Illustrated Carpenter and Builder;" and Mr. Jones, a contributor to "Design and Work," a publication somewhat similar in scope and purpose, and equally valuable to the scientific amateur, has given in the pages of the last-named periodical a simple but effective method of holding the four sides of the frame together while gluing up the corners and securing them with brads. In fig. 473, A A represents a large board of about 1in. in thickness, clamped at the ends to keep it from warping. The board should be large enough to take a good-sized frame, say 3ft. by 2ft. In place of a board the top of the bench, if it be clean and perfectly level, or a kitchen table, or any small deal table whose top is in one piece, will do equally well. The advantage of having a board for the purpose is that its edges can be planed perfectly square and true. To prepare for putting the frame together, first set off and lay out an area exactly the size of the picture-frame, marking its limits on the surface of the board. These lines, if shown in the figure, would coincide with the outer edge of the frame, and the outer edge of the frame, as defined by the lines B C, C D, D E, and E B, may be taken to represent them. Now take some small blocks, and screw down the four marked F, G, H, K to the table or board, close to and touching the lines B C, B E. The four blocks lettered L, M, N, O should be screwed to the board about ½ inch from the edge of the frame, as shown in the drawing. Having glued the ends of the pieces, place P and Q so that their outer edges B C, B E are against the blocks F, G, H, K. Then place the pieces R and S in the position shown in the figure, and lock all the pieces closely and tightly together by driving in wedge-shaped pieces of wood, as shown at T, T, between the blocks L, M, N, O, and the edges of the frame D E and D C. The frame

How to put frame together.

Contrivance for holding pieces.

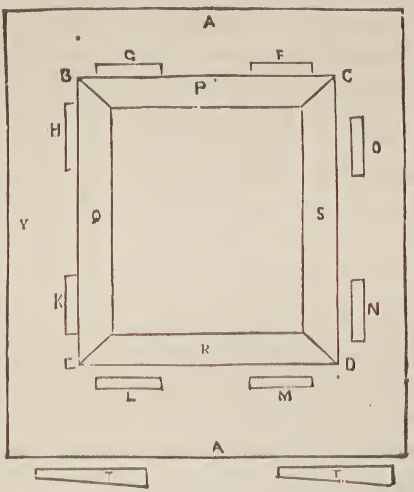


Fig. 473. Board for fastening up sides of frame.

must remain locked up until the glue is set, when the wedges may be removed and some thin brads driven in at each corner to strengthen the frame.

Suggested improvements.

924. To save trouble, instead of the blocks lettered F, G, H, K, it will be better to have two slips of wood permanently screwed to the surface of the frame along the edges X, Y, parallel to these blocks. It will then only be necessary to set off the lines against which the other two sides of the frame will come with the T square, and screw down the blocks lettered L, M, N, O a little to the outside of them, so as to allow of the insertion of wedges for locking up the frame. Again, the blocks lettered L, M, N, O may be dispensed with altogether, and two clamps shown in plan and section in fig. 474 substituted for them. The action of these clamps and their construction will be readily understood from an examination of the figure, each part of which is similarly lettered for facility of reference. In each portion A is the board or table, and B the frame. The screw C, one end of which works into and against the block D, through which its pressure is transmitted to the frame, works through a nut or female screw in the block E. This block is notched to receive the edge of the board or table, and is fitted with a thumb-screw F below, by which it is immovably fixed before pressure is applied to the block D by the screw C. The amateur will not find any very considerable difficulty in making clamps of this kind for himself, or adapting others to serve the purpose in view.

Clamps for boards.

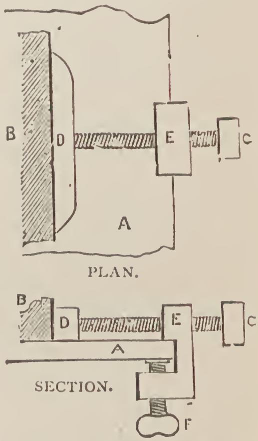


FIG. 474. CLAMP FOR FASTENING UP FRAME.

"Oxford" frames: their peculiarity.

925. From the ordinary picture-frame we must pass on to the "Oxford" frame, whose peculiarity is that the ends of the four pieces of which it is made, instead of being mitred together in rectangular corners, project each beyond the other in the form of a cross. Lengths of oak, properly rebated, may be obtained for making these frames, but the amateur may make them for himself without the slightest assistance of this kind, and of deal, which he can afterwards stain and varnish or French polish, or blacken in imitation of ebony, according to taste.

Materials for making them.

926. It will be useful to look into the methods of making the Oxford

frame from beginning to end, as this will also furnish the key to making a frame of wood already rebated for the purpose. Fig. 475 shows the frame complete and fastened together. It has been drawn on a large scale and somewhat coarsely, the better to exhibit its construction. A B, C D, E F, and G H, are four pieces of wood, say 1in. square when planed up. These pieces are all notched at suitable distances from the ends, the perpendiculars A B, C D being notched to half their thickness in the under surface to fit over E F and G H, which are notched to the same extent in the upper surface to receive them. The way in which the piece E F is notched is shown in the elevation of E F in fig. 476, K and L and the dotted lines above and below the notches showing how the upper pieces fit over and on to it. The edges of every piece are stop-chamfered, as shown in fig. 474, and small bosses or studs are frequently inserted at the intersection of the pieces to give an ornamental appearance to the frame.

Principles of construction.

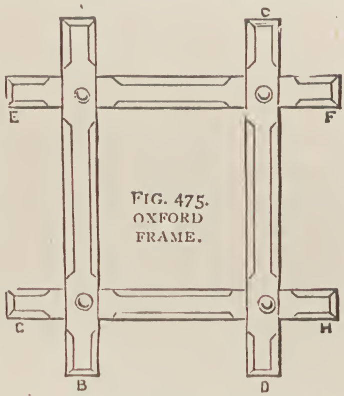


FIG. 475. OXFORD FRAME.

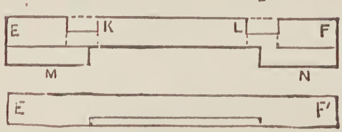


FIG. 476. ELEVATION OF TRANSVERSE BARS.

927. If the amateur has a rebating plane, and can use it, he will easily form a rebate in the inner edge of the under part of each piece; or after the frame is put together, before gluing up and pinning, the rebate may be marked and cut out with a chisel, the pieces being taken apart for the purpose. But, instead of doing this, pieces of wood of sufficient thickness to receive glass, picture, and backboard of the form shown at E′, F′, in fig. 476, may be cut out and glued or nailed to the under part of the frame. The effect of this is shown in elevation at M and N just above, in the same figure. Pieces of wood of this shape may be attached to either the vertical or horizontal pieces from end to end throughout; but in the others, whichever they may be, the rebate will be completed by putting on narrow strips between the pieces thus fixed, and pieces of the width of the frame on to the four ends to make the thickness the same throughout the frame and secure uniformity in this respect.

Simple way of making rebate.

928. Flower-stands and flower-stages will in all probability fre-

quently command the attention of the amateur; it will be desirable, therefore, to point out how these articles may be made, and to include in the information given on this point some directions for making hanging-baskets of a simple character for decorative purposes, both within doors and in the open air.

Flower-stands and stages.

929. Let us first take the stage on which pots containing flowers may be placed. Small stages of this kind are very useful in gardens of limited extent. They may be made square or semicircular in form; that is to say, in the shape of simple straight shelves rising one above the other, or in tiers of shelves returned, or in tiers of semicircles. In a garden where two straight paths intersect, a circular stage filled with flowers supplies a means of ornamentation that is both beautiful and appropriate.

The ordinary flower-stage.

930. The simple stage of three, four, or more straight shelves rising one above another is easily made. The general principles of its construction are shown in fig. 477. The great object is to keep each shelf clear of the one immediately above it, and to exhibit the flowers to the best advantage, causing them to conceal the stage or frame on which they stand as much as possible. To explain what is meant, let us suppose that the stage is intended for plants that range about 12in. in height, which are contained in pots 6in. high. Now the top of the plants in the lower row should be on a level with the rims of the pots in the row just above it; and consequently, as each plant and pot are together 18in. in height, the distance between the shelves should be 12in. This general rule will be sufficient to guide the amateur in making special stages for special purposes. Thus, for example, for staging auriculas the distance between the rows of shelves need not be so great as for pelargoniums. In a stage for a greenhouse this rule cannot be carried out owing to the variety of plants that are put on the stage. For greenhouse stages, speaking generally, 9in. shelves made of rails, and not solid—that is to say, of boards—at a height of about 15in. one above another, will be found suitable and convenient. For large plants more breadth may be given to the shelves. Of course it will be understood that tall-growing plants should be placed behind those of shorter growth, so as not to hide the shorter ones from view.

Simple mode of construction.

Width of shelves for plants.

931. In the accompanying illustrations, in which, for the sake of showing the construction as clearly as possible, the shelves have been drawn of the same width and height, fig. 477 shows a stage of the simplest possible construction, that may be

Easy stage for amateur.

put together in the course of a very few hours. All that is necessary is to screw some uprights and transverse pieces together at right angles to each other, so as to form the two ends. If the stage be a long one, intermediate supports of the same construction must be introduced. The supports are then connected by rails as at A, B, C, which form the shelves on which the pots stand. Horizontal rails should be

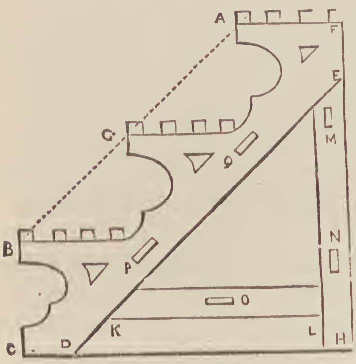


FIG. 478. ORNAMENTAL FLOWER-STAGE.

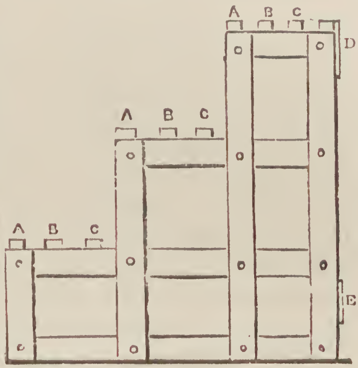


FIG. 477. SIMPLE FLOWER-STAGE.

placed along the back of the structure as at D and E, and additional strength should be given to the frame by diagonal braces at the back, and by braces in front of each step, if the frame be a long one. A neater and lighter appearance will be given to the frame if the supports are made of 1½in. stuff halved into each other; but this will take time, and if the amateur can give time to the construction of his frame, he may as well make it more ornamental in character as shown in fig. 478.

932. To make this, a broad plank, as indicated by the dotted line A B and the solid line D E, must first be taken, and cut so as to present the form of brackets at A, B, and G, on which the rails that form the shelves are laid. In the drawing the brackets look disproportionately long, but this appearance will be obviated by making the shelves narrower and the height between them greater, as the amateur will find if he take the trouble to work out a design on paper for himself. To support the diagonal bracket-board an upright E H is mortised into it at the back, and the diagonal board and upright are further connected by a transverse rail K L. To keep the supports together and to strengthen the frame, rails may be placed parallel to the shelves, as shown at M, N, O, P, and Q.

Stage with brackets for rails.

The above illustrations and description will suggest to the amateur other methods of making flower-stages for the greenhouse or for the garden in this simple form.

933. Square, semicircular, and circular stages assume a pyramidal form, and provision must be made for the return of the shelves round the sides. The supports must be made in the same way, but on consideration it is clear that they must be arranged as radiating from a common central and vertical line as at A in fig. 479. In this figure a combined representation is given of the plan of a semicircular stand and of a rectangular stand whose length is just twice its width or depth. In no case should the relative proportion of a rectangular stand be less than 2 to 1 for length and depth. When the length C D is more than twice A B, there must be two supports instead of one in the centre—that is to say, the construction of the parts A B C E, A B D F must be as shown in the diagram, and the extra length made up by the rails that intervene between the two uprights or supports that take the place of the single support A B. It will be seen that in the rectangular stand the supports A E, A B, A F are equal and symmetrical, and so are the supports A C, A D, but these latter being diagonals will be longer than the others, and the amateur will find it necessary to obtain their exact shape by means of an elevation, which after all that has been said he can easily make for himself. In the semicircular form all the supports standing on radii of a circle will be equal and symmetrical. The amateur will readily understand that the supports do not meet in *a point* at A. They may meet, if it be thought requisite, *in the vertical line that passes* through A, but they are cut off level at the top so as to support in the one case the rectangular shelf K L N O, and in the other the semicircular shelf K M O, that cap the respective pyramids. Thus in the rectangular stand the slope of the supports in plan, as well as the ground or base on which they stand, is represented by the straight lines K E, L C, M B, N D, and O F, and in the semicircular stand by K E, P G, M B, Q H, and O F. The rails or boards of which the shelves are made are mitred on the brackets proceeding from the supports in the rectangular frame; but in the semicircular frame, if small,

Stages of various forms.

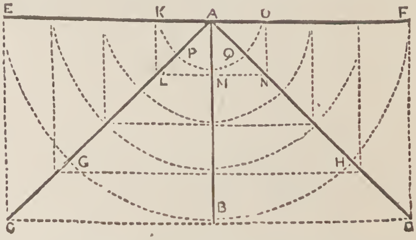


FIG. 479. PLAN FOR RECTANGULAR AND SEMICIRCULAR FLOWER-STAGES.

Rectangular stand.

Semicircular stand.

the boards may be cut in quadrants, or if large, extended merely from bracket to bracket as in the rectangular form.

934. Flower-stands admit of an almost endless variety in their construction. Speaking generally of flower-stands, it may be said that they consist of a central support or stand, after the manner of the pillar of a round table, which is made to support two or three stages or shelves on which plants are placed. Stands of this description must of course be suited to the circumstances of the position which they are to occupy. For example, to stand before an ordinary window, a long and comparatively narrow form will be most suitable ; but for a bow-window a circular stand will be far more appropriate. It may be serviceable to the amateur to give examples of both of these flower-stands.

Flower-stands for windows.

935. A suitable stand for an ordinary window is shown in elevation in fig. 480, and in plan in fig. 481. A central pillar springs from a bold base supported on feet, and above each foot—the feet are four in number—is a bracket which may be let into the pillar at the bottom after the manner of the bracket-table described in section 772. From the top of each bracket springs a support which, with its fellows and the central pillar, helps to sustain the flat board A, which forms the lower shelf for the reception of plants. The pillar passes through this lower shelf, and is mortised into the upper shelf B, which is partly sustained by supports similar to those below, and springing like them from the central pillar. The boards may be furnished with an edging of wire-work, as shown in fig. 480. This is easily formed by boring holes in the boards, as shown at C in fig. 481, and sticking in loops of wire bent to the required shape. The wires may be bound together at the point of intersection by very fine wire, which will serve to strengthen the edging. The form of shelf shown in fig. 481 may be converted into an oval if preferred, but it is given as drawn here because the upper shelf B will take three small pots better than if it were

Flower-stand of wood and wire.

Pillar.

Supports for shelves.

Wire edging: how to make it.

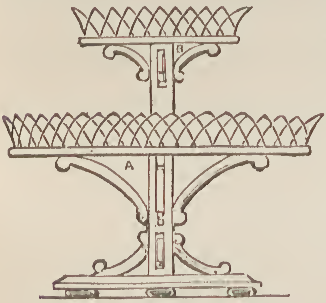


FIG. 480. FLOWER-STAND FOR WINDOW.

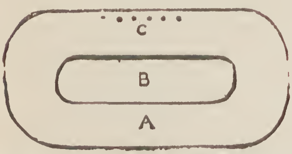


FIG. 481. PLAN OF FLOWER-STAND.

oval in shape. In making any stand of this kind B should be made sufficiently wide and long to receive three saucers—for the pots must be placed in saucers—and A should be at least three times the width of B.

936. A suitable and very pretty stand for a bow-window is shown in fig. 482. In this also a central pillar springs from a bold and handsome base, ornamented with brackets or bracket-like projections, which may be made as elaborate as possible by fret-sawing. The projections may be rendered very effective by making them in the form of dwarfed flying buttresses. The diagram, for the sake of showing the construction of the upper part of the stand as clearly as possible, is in section.

Flower-stand for bow-window.

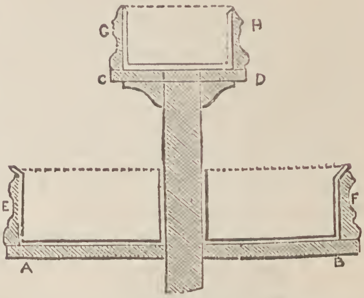


FIG. 482. FLOWER-STAND FOR BOW-WINDOW.

Mode of construction. From the edge of the shelves A B and C D springs an upright edge formed of a bold moulded board, or board enriched with mouldings, carried high enough to conceal the pots, as shown at E, F, G, H. To suit the mode of construction A B and C D should be octagonal in shape, and C D be just large enough to contain a single pot. The cases thus formed should be lined with pans or trays of zinc, there being two trays for the lower part so that they may be conveniently lifted out when necessary. The trays will catch and retain any surplus water that may drain away from the pots when the flowers are watered. The interstices between the pots may be packed with moss, which will keep everything in the stand fresh and cool, and so render it needless to water the plants too frequently. The zinc cases are shown by the black lines connected by dotted lines at the top. The stand should be stained and varnished, the rich brown tint thus obtained presenting a marked contrast to the various greens of the foliage of the plants and the brilliant hues of the blossoms.

Zinc cases for plants.

Staining and varnishing most suitable for flower-stands.

937. Hanging-baskets form a pleasing decoration for greenhouses, bow-windows, halls, passages, etc., and any places in which they can be conveniently suspended. For walls they may be made in the same form, the mode of suspension being adapted to the position. For example, if made in a rectangular or semi-octagonal form, the part that touches the wall may be made higher than

Hanging-baskets.

the other sides, and a hole made in it so as to hang the box on a nail or hook driven into the wall for its reception.

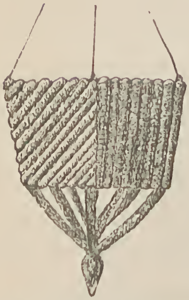


FIG. 483. HANGING BASKET.

938. Fig. 483 affords a pretty example of a hanging-basket. To make this five pieces of wood must be cut out and nailed together to form bottom and sides, and the sides, if not the bottom, must then be covered with pieces of hazel, or other straight sticks sawn or split in half, and coated with varnish or boiled oil. The pendant below is formed of crooked pieces of wood strung on wire, the whole terminating in a fir cone or some rustic ornament. A wire attached to each corner forms the means of suspension from the roof. Fig. 484 is introduced to show how a bracket may be treated in a similar manner. A very effective square or hexagonal basket may be made by cutting some hazel rods or other straight sticks into equal lengths, and stringing them on wire in the manner shown in the accompanying diagrams. Fig. 485 shows how the bottom of such a basket is made. A piece of wood of the form intended for the basket — whether triangular, square, pentagonal, or hexagonal, it matters little except that numbers divisible by two are more convenient for the number of sides of these baskets—is taken, and two pieces of wire, which have been previously passed through two of the sticks that have been cut, are passed through the holes in the corners of the bottom board, the ends pointing upwards. On these wires sticks are strung in alternation until the basket has been carried high enough,

Modes of making hanging-baskets.

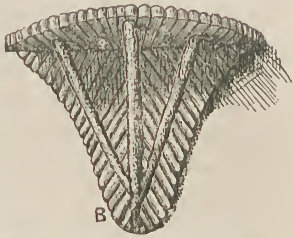


FIG. 484. RUSTIC BRACKET.

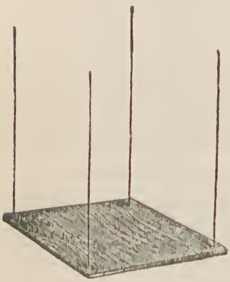


FIG. 485. FOUNDATION FOR BASKET.

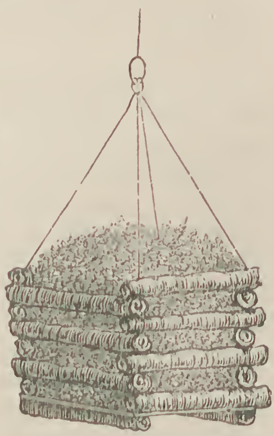


FIG. 486. HANGING-BASKET.

as shown in fig. 486. The ends of the wires must be looped by the aid of a pair of pliers, and passed over an S hook, by which the whole may be suspended. The uses of such a basket are numerous, and will suggest themselves to the amateur. A wall-basket or pocket may be made, as it was said, by forming half a hexagonal or octagonal basket, and suspending it on a nail after covering the exterior with cleft sticks, after the manner shown in figs. 483, 484, or with virgin cork. Any pretty hanging plant looks well in such a basket. A spike or two of lady-grass, surrounded by toad flax, which will fall over the basket in a close green mass, sprinkled with pale purple and yellow flowers like snapdragon or antirrhinum blossoms in miniature, is highly effective, though simple in character.

Glazed window-box.

939. Closely akin to the subject which we have been considering, though by no means identical with it, is the glazed window-box, which, in some situations, takes with advantage the place of the window-box or tray. This kind of window-box is rather desirable for masking a dreary look-out against a blank wall, than for windows from which a good view can be obtained.

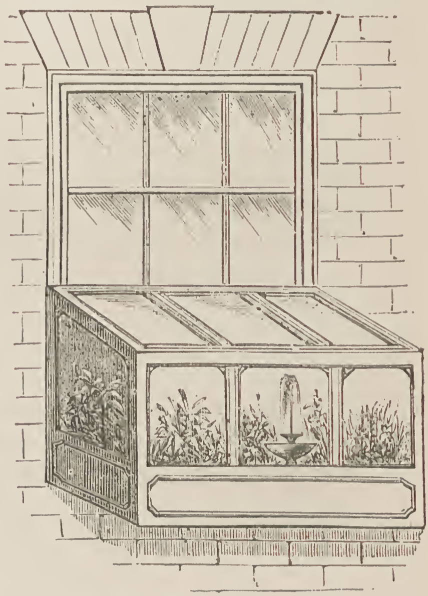


FIG. 487. GLAZED WINDOW-BOX.

General form of window-box.

940. The general form of the glazed window-box is shown in fig. 487. It is supported on the window-ledge, and secured to the outer board of the window-frame in which the sashes are hung. A sound piece of wood must be taken for the bottom, about 18in. wide, and equal in length to the distance between the reveals of the windows on either side. The sides and front of the box consist of three frames, entirely filled with glass, or with a wooden

Bottom and sides.

panel at the bottom and the rest glass as shown in the engraving. The bottom should be firmly screwed to the sides which rest upon it; or, if preferred, they may be dovetailed into

it. The front should be constructed so as to rest on the bottom and against the edges of the sides, to which it must be secured with screws. If desired the front may be made in two parts, the upper part being hung to the roof like the light of a greenhouse to open outwards and admit air; or a single pane may be made to open outwards. The roof rests on the front and sides, and should be so constructed as to abut as closely as possible against the lower rail of the upper sash, to which, if it can always remain closed, a strip of indiarubber or other substance, elastic or of metal, may be fastened, so as to lap over the edge of the roof next the sash and prevent the entrance of rain. Access is obtained to the window-box by opening the lower sash. So much has now been said on the mode of putting the different parts of a structure together, that it is unnecessary to go into minute details which the amateur already understands and can put in practice for himself.

Front and roof.

Access to box: how obtained.

941. A fountain is a charming embellishment for a garden, and the principles of its construction may be easily understood. In towns where one has to pay for most if not all of the water that is consumed in the house, fountains are almost prohibited articles, unless rain-water can be stored for the purpose in a convenient situation. The jet of water in a fountain depends on the general principle that water will always rise to its own level. If, then, there be a cistern twenty feet, let us say, above the surface of the ground, and a pipe be led from the cistern in a downward direction and then turned up, the orifice at the extremity being brought in about four or five feet above the level of the ground, as long as there is any water in the cistern water will issue from the pipe in a vertical direction if the pipe be upright, or in any direction in which the pipe may be turned. Water, indeed, will well out from the pipe's mouth until it has sunk in the other leg to the height of the pipe from which it has been issuing. When the cistern is full the jet will be strongest, and as the weight and mass of the water in the cistern decreases the jet will become weaker and weaker, until it merely rises out of the orifice and trickles down the pipe.

Fountain in garden.

Principles on which they act.

942. An exemplification of what has just been said is given in fig. 488. In this, if a pipe as B were attached to the cistern C, the water would rise in the pipe B to the level of the water in the cistern, and no higher; but if the pipe B were carried in the direction of A, and cut off a little distance above the level of the soil, the water would rise to a certain height above it, and then turn, by the force of gravitation, and descend to the

Construction and action exemplified.

ground in the manner shown in the drawing. If, then, it is desired to construct a fountain in a garden, as shown in section in fig. 489, a solid substratum (A) of concrete, or brick laid in concrete, must first be laid to a sufficient depth in the earth, and through this the pipes B and C must be led—B being the supply-pipe, and C the waste-pipe. The end of the supply-pipe should be in the centre of the basin A, to make which a dwarf wall should be built round the pipe, and the basin formed of concrete faced with cement, moulded with a board or iron to the requisite sweep and curvature in all parts as shown at D. A stop-cock may be put in that part of the pipe B which rises in the basin to prevent the fountain from playing

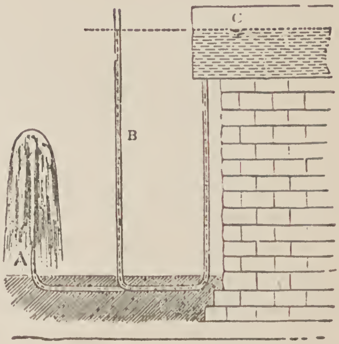


FIG. 488. PRINCIPLE OF FOUNTAIN.

when it is desired to do so. The pipe B communicates with a cistern, or some other source of supply. The basin will always remain full of water as high as the edge of the waste-pipe or overflow-pipe C, but when it rises higher than this it will be gradually drawn away through C, which must communicate with some drain. Of course, in a fountain of this kind there is a considerable waste of water unless the surplus can be taken through the waste-pipe to some place of storage, and raised by a small pump for use in the garden.

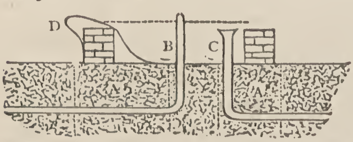


FIG. 489. CONSTRUCTION OF GARDEN FOUNTAIN.

943. The principle that water will rise only to its own level is frequently lost sight of in contrivances that at first sight appear to be very ingenious. This is apparent in the following description of a so-called inexhaustible fountain taken from the "Illustrated Carpenter and Builder." In fig. 490 X and Y represent two wide-mouthed bottles closed with bungs. The bottles are placed one above another, X being supported on a wire stand. A is a basin or receiver through the bottom of which the pipe E passes, its lower end passing through the centre of the cork that closes X. To the bottom of the basin A another tube C is attached, which is bent in such a way that it may pass through the cork of the bottle Y, reaching nearly to the bottom. Another pipe D issues from the cork in Y and enters the cork in X. When the different parts have been put to-

Inexhaustible fountain.

gether, pour water into the basin A. The water will pass through C and fill Y. When Y is full the continued pressure will force the water through the pipe D and fill X, and when X is full the water will rise through E and we are then told the fountain will begin to play. Now this will not be the case, the water will rise in the pipe E to the level of the water in the basin A, but no higher, and if the pipe E be long enough, and the basin deep enough, the rising of the water both in pipe and basin will be *pari passu*. The fountain is altogether a fallacy, as any one who tries to make it will find.

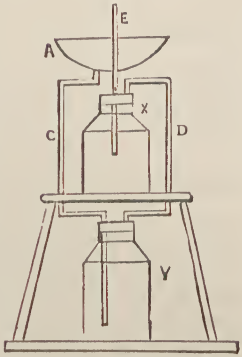


FIG. 490.
INEXHAUSTIBLE FOUNTAIN.

944. Some persons object to swings, and with good reason when they are used roughly and recklessly. A medical man, commenting on amusements for children which are more or less attended with danger, has recently (1880) called attention to a case in which a child aged ten had died from an attack of peritonitis due to irritation set up by excessive swinging. This is a very favourite exercise with girls, and it ought to be impressed on parents and guardians that the immoderate use of it is calculated to produce grave ill. Muscular spasm of a severe kind is sometimes set up by it, and often very distressing back and head aches. With many children there is a strong temptation to persist in the motion, which produces a certain pleasing sensation, and whenever this is found to be the case, every tendency to it ought to be immediately checked: much irreparable mischief—immediate and future—may thereby be prevented.

Swings; danger arising from their use.

945. On the other hand, however, when strict moderation in the exercise of swinging is enforced, and due care is taken, the swing and its accompaniments form an agreeable means of recreation for children. A swing may be put up for a little child by screwing two hooks into the lintel of a doorway, and allowing the cords to hang from the hooks and the swing to move backwards and forwards through the doorway. This, however, is only fit for very little ones, and for bigger children the swing must be constructed in the following manner.

Swing for little children.

946. First of all, two strong uprights should be provided at least 12ft. in length and 4in. in width and thickness. These uprights must be mortised, as shown in fig. 491, at the lower end B into a cross

piece D E, from 5ft. to 6ft. long, and the same in width and thickness, and strengthened by two struts F and G. The base D E and the greater part of the struts F and G are buried below the earth line N O; the superincumbent weight of earth pressing on base, struts, and upright keeping the uprights from swaying about when the swing is in motion. The end A of each upright is mortised into a cross-beam shown in section at C in fig. 491, and in elevation at C in fig. 492. Two strong hooks are inserted at H and K, to which the ropes of the swing are attached, being worked round an iron eyelet-hole which slips over and on to the hook, which is shown on a larger scale at X in fig. 493. The ends of the ropes are passed through holes in the seat of the swing, as shown in fig. 493, and secured from slipping through by means of knots. When the ends of the cross-beam C are made to project some distance beyond the uprights as shown in fig. 492, the projecting arms or horns may be made available for two other hooks as at L and M, from one of which a rope may be suspended, and from the other a pole, for instruction and practice in climbing ropes and poles, an exercise which may prove useful in after life.

How to put up a swing.

The uprights.

Hooks and ropes.

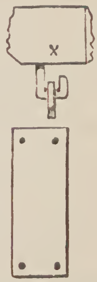


FIG. 493. HOOKS AND SEAT OF SWING.

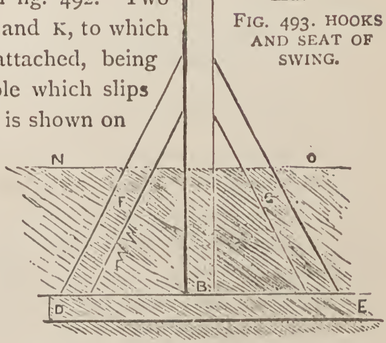


FIG. 491. SWING (END ELEVATION).

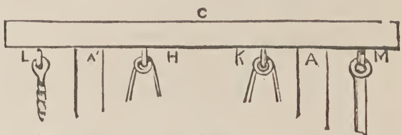


FIG. 492. SWING (FRONT ELEVATION).

CHAPTER X.

OUT-DOOR STRUCTURES FOR THE GARDEN: CUCUMBER-FRAME, GREENHOUSE, SUMMER-HOUSE, FOWL-HOUSE, PIG-STY, RUSTIC WORK, AND STEPS.

Out-door Structures in Garden—The Cucumber-frame—Its various Uses—Construction of Glass-frame—Sides of Frame—Top and Bottom—Frame should take to Pieces—Board suitable for Purpose—General Proportions—Arrangements for taking Frame to Pieces—Lights for Frame—Ordinary size of Lights—Bearers for Lights—Contrivances to Carry off Water—Lights always Useful in Garden—Suitable size for Small Lights—Greenhouse—House must be adapted to Situation—Example of adaptation to Circumstances—Circumstances of Situation Described—Mode of Construction adopted—Floor of House: why Lowered—"Lean-to" Greenhouse—Design for "Lean-to" Greenhouse—Roof of the House—Details of Construction of House—Simple Protection for Fruit-trees—The Orchard-house—Useful Structure for Amateur—Orchard-house must not be too Small—Posts for Orchard-house—Wall plate—The Rafters—Provision for Glazing—Placing of the Glass—Ends of the House—Mode of securing Ventilation—Arrangements within the House—Cost of Building—Purposes to which it may be Applied—Fruit-shed—Buildings Suitable for Gardens—The Aviary or Bird-house—Levelling and Staking out Area—Construction of Building—Base-boards—Rafters and Roof—Sides of Structure—Swing-flap at Bottom—Perches for Birds—Sides in exposed Situation—Protection in Stormy Weather—Bottom of Aviary—Brackets, etc., for Building—Hutches for Rabbits, etc.—Rabbit-shed—Outer Wall: its Construction—Inner Wall, and Trap-hatches—Roof and Railing—Soil suitable for Rabbits—Fowl-keeping Profitable—Things necessary to Success—Construction of House and Run—Amateur's Suburban Fowl-house—Plan of Structure—General Arrangement of Yard—Poles for Roosts—Interior of Roosting-place, etc.—Position of Nests—How to Build the House—Frame for Front—Partitions, Roosting-poles, and Nests—Roof and Gutter—Ventilation—Padlocks to Doors—Hints on Feeding Poultry—Useful Feeding Trough—Its Construction—The Pigeon-house—Construction of Ordinary House—Floors of Boxes—Roof and Cap—Pigeon-house should be easy of Access—How to Make it so—Pipe in Centre of Tub—Construction of Boxes—Entrances and Ledges—Arrangements for Raising and Lowering Tub—Construction of Roof—Keeping Pigs—Situation of Pig-sty—Plan of Structure—Bed and Drainage—Rafters and Roofing—The Yard, and its Fencing—Feeding Trough—Materials for Building must Depend on Locality—No Structural difficulty in Pig-sty—Pigs should be kept Dry—The Summer-house: its Position—Hexagonal Summer-house—How to Build it—The Posts: how to fix them—Floor of Building—Wall Plate for Rafters—Details of Construction—Closing in Sides of Building—Rustic Work: what it is—Things that may be made in Rustic Work—Its Carpentry and Joinery—Examples of Rustic Work—Halving, and Mortise and Tenon Joint—

Modification of these Processes—Directions for Notching—Shoulder of Tenon, etc.—Suggestions for Framing Rough Timbers—Garden Furniture—Garden-seat —Method of Construction—Ornamental Work—Arms of Seat—Garden-seat for one Person—Rustic Table—Rustic Steps and Fences.

947. As the general principles on which sheds and out-buildings in the garden, etc., are constructed will be fully discussed in Part III. of "Every Man his own Mechanic," in which all branches of the building trades are treated, occasion may be taken to dwell here on a few peculiarities in out-door structures in the garden, which cannot be conveniently treated elsewhere.

Out-door structures in garden.

948. First among these the cucumber-frame, or frame and lights, presents itself, a structure which is not only useful for raising, rearing, and ripening cucumbers and melons, but also for constituting a covering for a cold pit in which half-hardy plants may be protected from the severity of the winter. The description of this kind of frame and light will be sufficient to guide the amateur to the construction of various frames and lights for growing grapes, strawberries, and other delicious fruits which thrive and ripen all the earlier and quicker under glass than in the open air.

The cucumber-frame.

Its various uses.

949. In fig. 494 the details of the construction of the glass-frame are shown. No. 1 is an elevation of the side of the frame, in which it is sought to show, among other things, the suitable slope of the light which lies within the side-slips, one of which is shown in No. 1 by A A, and in section by A, B in No. 2. A frame may be of 6ft. × 4ft., or 6ft. × 8ft., the latter being double the size the former. The side-pieces form a rebate with the sides of the frame, so that the light works up and down on the edges of the sides of the frame and clears the top and bottom nicely. The side-pieces confine the action of the frame, keeping the frame in its proper place, and preventing it from moving in a lateral direction and being pushed over the side of the frame. The top, bottom, and sides of the frame may be dovetailed together, but a large

Construction of glass-frame.

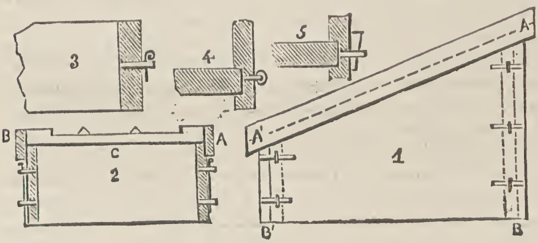


FIG. 494. FRAME AND LIGHTS.

Sides of frame.

Top and bottom.

frame when put together in this way so that it cannot be taken to pieces forms a heavy and cumbersome article to put away out of sight and under cover when it is not wanted. The amateur will find hints on glazing the light in Part III. of this work. We will now go into the construction of a frame that may be taken to pieces and put together at pleasure.

Frame should take to pieces.

950. Stout boards that will be full 1in. or even 1¼in. when planed down, should be chosen. The sides must be made of the shape shown in No. 1 at A B B′ A′, the hinder part, A B, being about thrice the height of the bottom piece. This will provide a sufficient slope for the light, which should be at an angle of about 22° 30′ with the horizon. Suppose the end A′ B′ to be 12in. in height, and B B′ to be just about 6ft. long, the end A B would be rather more than 3ft. high to obtain this slope. The amateur, however, may vary the height of the back from twice to three times the height of the front, as he may find convenient or suitable to circumstances. In order to take the frame to pieces and put it together again at pleasure, the front, back, and sides may be connected by cutting slots in the sides in a horizontal direction and attaching eyes to the edges of the top and bottom in such positions that they will pass through the slots cut for their reception in the sides. When the eyes or staples, for either may be used, have been passed through the slots when the frame is put together, the whole structure may be kept together by passing wires through the loops of the eyes, as shown in 2, 3, and 4, or pegs through the loops of the staples, as shown in 1 and 5. The amateur must remember that slots for eyes, the nature of which is clearly shown in 4, must be *horizontal*, but those for staples must be *vertical*. In 2 and 3 the edge of the bottom is shown as simply touching the sides, but in 4 and 5, both of which represent the plan of a corner of the frame, the edge of the top or bottom is shown fitted into a groove ploughed for its reception, about 1in. or 1½in. from the edge of the side. The frame is more solid and air-tight when made in this way.

Board suitable for purpose.

General proportions.

Arrangements for taking frame to pieces.

951. The end of the light is shown at C in 2. As instructions for making the frame and glazing it will be given elsewhere, as it has been said, all that is necessary to impress on the amateur here is that if he is making his lights himself he can make his frame first and adapt his lights to it; but if he procures frames for his lights all ready made, it will be needful to adapt his frame to his lights, making an accurate working drawing to scale, in order

Lights for frame.

to determine the dimensions of the parts of the frame with accuracy.

Ordinary size of lights.

No light for a frame of this description should be larger than 6ft. by 4ft. The frame may, if necessary, be 8ft. by 6ft., or even 12ft. by 6ft. ; but to cover these two and three of the ordinary 6ft. and 4ft. frames must be used, supported by bearers running from top to bottom of the frame—*one* bearer being required to take the edges of two lights where they meet in the centre of the frame, and *two* bearers for three lights. These bearers should be about 3in. wide, notched into the frame at top and bottom, so that their upper surface may be level with the topmost edge of the top and bottom, and the upper edges of the sides. It is better to screw a bar of wood about 1in. square, or 1in. wide, and as high as the thickness of the lights, to separate them. Grooves should be cut with the gouge down the edges of the sides of the frame, and down the bars on which the edges of lights may rest. These serve to carry off any water that may make its way in between the edge of the light and the rebate in which it moves up and down. Thus in fig. 495 these grooves are shown at X, X, X, A being the section of outer side of frame working in rebate formed by side-slip D, and on edge of side C; and B, B, sections of inner sides of frames working in rebates formed by the piece E screwed down the centre of the wider bar, F.

Bearers for lights.

Contrivances to carry off water.

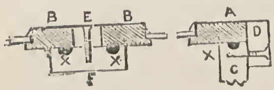


FIG. 495. GROOVES IN FRAME.

952. Any number of lights, large and small, can be used in a garden for the protection of plants and the more successful raising and rearing vegetables and flowers, and the production of fruit. The amateur can scarcely have too many of them. In spring, under a number of small lights placed together edge to edge, salads, potatoes, early carrots, and strawberries may be grown to come to table long in advance of those which are grown in the ordinary way. The only framing that is required may be made of long pieces of board higher behind than in front, joined at the ends and connected and strengthened by bars of wood from back to front, on which the edges of the lights rest. For small lights for use in a side border in long continuous shelter-frames of this description, 4ft. by 3ft. is a convenient size. All frames should be well painted and receive a fresh coat yearly.

Lights always useful in garden.

Suitable size for small lights.

Greenhouse.

953. As in the case of the garden-frame and light, the general principles involved in the building of a greenhouse, as far as the carpentry is concerned, have been given elsewhere,

and it is only on questions of detail that there is any necessity for us to dwell here. In all cases the amateur must suit the peculiar form which his house will assume to the ground on which it is to be built, and to the peculiar circumstances of situation.

House must be adapted to situation.

954. In order to give a practical illustration of what is meant by adapting the form of the structure to circumstances, the writer cannot do better than describe, by the help of the annexed sketch, fig. 496, what he has done himself in a position that presented some difficulty. One or two trifling deviations have been made from what was actually done, in order to render the sketch and description more useful to amateurs generally. A B represents, or must be considered to represent, a glass door in section leading out on to a landing, C, forming the top of a flight of stone steps D, E, F, leading to the garden, the level of which is represented by the earth-line G H. There were iron railings run with lead into the edges of the steps to prevent any one from falling into the garden, and to act as balusters to the steps ; K L M shows the height of a brick wall, 6ft. high in the lowest part, which divides the garden from an alley or narrow passage which runs between the writer's garden and that of the next house, and forms a thoroughfare from the street in front to another behind. A greenhouse was very much wished for, but to have raised it above the wall would have exposed the roof to damage, and blocked the view from the door A B. The only thing to be done to get sufficient headway within the house was to put the floor below the earth-line, and this was done accordingly ; an excavation, O P Q R, being made 18in. below the level of the earth-line shown by G H. A frame P S was made, in which was a swing window T hung to the top rail of

Example of adaptation to circumstances.

Circumstances of situation described.

Mode of construction adopted.

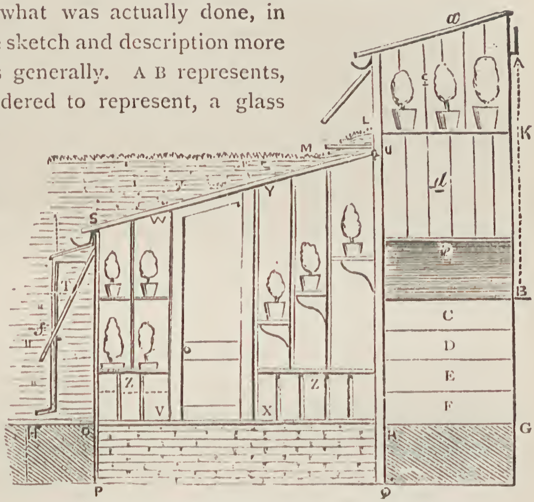


FIG. 496. GREENHOUSE SUITED TO SITUATION.

the frame by hinges to open outwards. Another frame, Q U, was put up behind, butting against the steps from which the railings were removed. On these frames, before and behind, the roof U S was laid with a ventilator at U upwards. A rail O R was mortised at the level of the earth-line into the uprights P S, Q U, and short rails Z, Z on either side, between these uprights and the uprights V W, X Y, which were mortised into the rails O R, U S, and formed the frame for the door. A nice little house, 6ft. high in front, 8ft. high behind, and about 5ft. 6in. wide, and 7ft. from back to front, was thus formed, capable of holding a great many plants on the platform and shelves in front, and the stage of three tiers behind, the positions of which are indicated by drawings of flowers in pots in the sketch. The openings between the uprights from R Q to O P and in front were filled in with brickwork to keep the soil from falling in ; and the space between O R and the short rails Z, Z, on either side of the door was boarded up, the boards being placed vertically, and chamfered slips nailed over the junction of the boards to hide their meeting, and to provide against possible shrinkage. To cover in the steps and landing in front of the glass door A B, uprights were mortised into the top rail U of the frame at the back to carry another rail on which the zinc-covered roof *a* was sustained, the long opening between these two rails being glazed and fitted with a swing window, as shown in sketch. The glass at the top of the wall from L to K was chipped off and a shelf put in its place, which is useful for flowers. The opening at *c* was match-boarded, and so was the wall at *d* between the shelf L K and a seat *e*, which was put up across the inner end of the landing about 16in. above it. The back of the greenhouse, from a little above the level of the seat to the top rail U on which the roof rests, is glazed, which allows a view of the interior of the house to any one who is sitting on the seat *e*, and from the passage within the glass door at A B. Although everything is on a small scale, the house is convenient and so is the seat. A step is placed within the house midway between the sill of the door and the floor to facilitate ingress and egress. The water from the roof which runs into the gutter below S is carried by the shoot *f*, which is attached to the side of a small buttress, down to the ground at H, into which it soon soaks away.

Floor of house: why lowered.

955. Unless the floor of the house had been carried to the depth of 18in. below the ground level, it would have been impossible to have got a house of fair height conveniently placed, for reasons that have been already stated ; and when sketches were being made for the plan, elevations, etc., the covering in of the landing C with the verandah-like roof *a*, and the formation of the shelf

L K, and the seat *e* soon suggested themselves. Thus, in whatever building the amateur may undertake to construct, it is not only necessary for him to adapt the structure to the circumstances of position, but to consider how and in what way the position itself may be modified so as to promote convenience in the building, whatever it may be, that is about to be reared upon it.

956. The greenhouse just described is what is termed a "lean-to." The method of constructing roofs on this principle, and span and hipped roofs, will be fully described in the concluding portion of this work. The roofs of glass structures should be made as light as possible, having due regard to strength, and provision should be made for ventilation. That the amateur may not be without a suitable design for a pretty "lean-to" greenhouse to be erected against a wall, and having glazed ends in one of which is the door, the preceding remarks on greenhouse building and building out-houses in general may be fairly supplemented with illustrations and brief description of such a structure.

"Lean-to" greenhouse.

957. The greenhouse shown in the accompanying diagrams, of which figs. 497, 498 are the front and end elevations of the house, may be built either as a lean-to against a brick wall, or independently of any wall or structure behind, in which case it must be furnished with a back. A useful feature in this design is that any greenhouse built on this plan can be easily taken to pieces and re-erected in any other place at small cost. The ends are each framed in one piece to move bodily ; the front and roof may be made each in one piece, or in separate parts. The most feasible way would be to make the woodwork below, shown as panels in the drawing, and the glazing above, in four separate pieces, as the two pieces in the centre could then be made to open for ventilation.

Design for "lean-to" greenhouse.

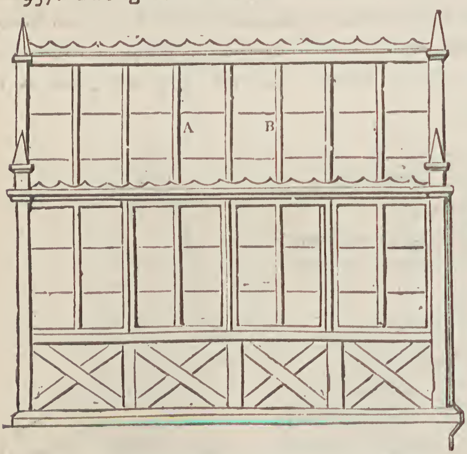


FIG. 497. GREENHOUSE (FRONT ELEVATION).

958. The roof may be made in three pieces, and in this case the

two central panels should terminate at a cross rail set across the frame at A and B, to admit of small lights above, between this rail and the top rail of the roof for ventilation.

Roof of the house.

The house stands on a platform or sill piece of oak framed separately, and the sills or lower rails of the framing above are screwed down upon it. It is almost needless to say that the oaken sill should be bedded on concrete, and that the floor of the house should be formed of the same material, sloped from all sides to one corner, at which an outlet and drainage should be provided for surplus water that may fall on the floor when the plants are watered. For the sake of ornament, circular heads may be made to the lights, if preferred to square or rectangular heads. In figs. 499, 500, and 501 the details of the method employed in bolting the front (and back, if the house be furnished with a wooden back) to the ends, and the roof to the uprights at front and back are clearly shown. In fig. 499 the plate A is mortised into the post B, and a hole is bored with an auger through post and tenon until a recess notched in the plate below A is reached, in which the nut is held until the end of the bolt has been passed through it. The nut, which is circular, with notches in its edge like the milling on a coin, is then screwed up tight with a screw-wrench made in the form of a large pair of bent pliers, until the post is brought as closely as possible against the tenoned end of the plate.

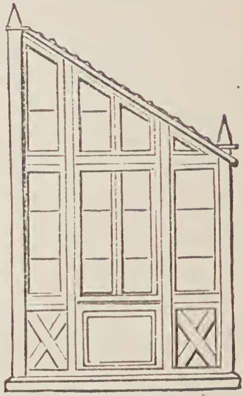


FIG. 498. GREENHOUSE (SIDE ELEVATION).

Details of construction of house.

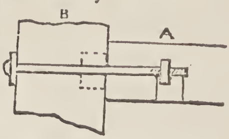
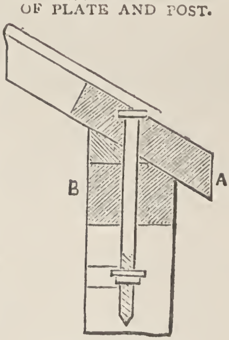


FIG. 499. CONNECTION OF PLATE AND POST.



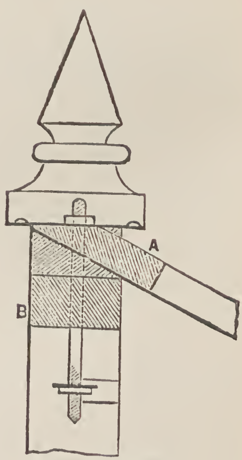


FIG. 500. FRONT. FIG. 501. BACK.
CONNECTION OF ROOF AND UPRIGHTS.

The framing of the roof is secured in precisely the same manner as shown by the bolts, etc., in figs. 500, 501. In these the shaded parts of the top, lettered A, represent in fig. 500 the front rail, and in fig. 501 the back rail of the roof; and in each of these figures the shaded part B represents the top rail of back and front respectively, for even if the back be formed by a brick wall or the wall of a house or any other structure, a wall plate from end to end will be required to help in supporting the framing that forms the roof. A fillet is nailed on the sides of the roof to give a finish to this part of the structure, and, to prevent the rain from finding its way to the bolts, caps, as shown in the front and end elevations, and in detail in fig. 501, are placed at the four corners of the roof. The difference in the form of the caps in front and the caps behind is perceptible in fig. 498. This mode of building a greenhouse and bolting the parts together was suggested by Mr. F. Collings in the "Illustrated Carpenter and Builder."

959. It is astonishing what heavy crops of fruit may be secured by a little glass overhead, and the means of breaking the violence of winds and protecting the trees from frost at the sides of the structure either by glazing or boarding, or even by trellis-work, or the slighter netting. Even a projecting coping along the top of a brick wall, to which netting or canvas may be hung in time of frost in April and May when the trees are in bloom, or even earlier, will save and secure a crop of fruit which would be very materially reduced, or perhaps entirely swept away, without protection of this kind.

Simple protection for fruit-trees.

960. Fig. 502 exhibits a section of a useful form of greenhouse for the amateur, which, by the removal of the stage in the centre and the heating apparatus shown at the sides, may be easily adapted to serve as an orchard-house ; the main points of difference between a greenhouse and an orchard-house being, that the greenhouse is neatly made and furnished with warming appliances, while the orchard-house is roughly put together without entire exclusion of the air at pleasure and without means of heating. In the illustration under consideration, C C represents the ground level. At A, A, A, A, four dwarf brick walls are raised, the outer ones being lower than the inner ones, so that lights may be placed from the latter to the former on an incline, covering in the cold pits B B on either side of the main structure. The floor of the pits is below the ground level, but that of the main structure coincides with the ground line. In the case of the orchard-house, if it be desired to gain height, the floor may be sunk below the

The orchard-house.

Useful structure for amateur.

ground level, as in the case of the cold pits; but this will be found inconvenient when it is desired to move the plants, or rather trees, out of the house in summer time, as when the floor of the house is neither higher nor lower than the ground without, the trees can be easily run in and out on a low carriage, whose wheels run on iron plates laid down for the purpose. When the fruit is grown on trees in pots, so that the trees can be moved from one place to another more readily, or

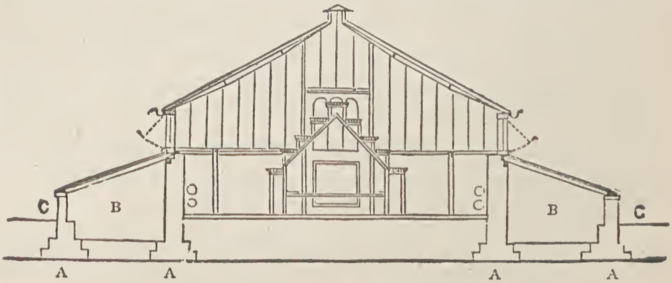


Fig. 502. Greenhouse or orchard-house.

when the trees are kept in the house always, the floor of the house may be sunk below the ground level as described.

961. Amateurs who intend to build an orchard-house for fruit-growing must remember that trees even when dwarfed will not thrive in a close, small structure. In Beeton's "Garden Management" the following description is given of a convenient form of house, a lean-to structure, 30ft. long and 12ft. 6in. wide, which is made in a very simple manner. No illustration is given, as the amateur can easily work this out for himself from the following description.

Orchard-house must not be too small.

962. Six posts of yellow deal, 5in. × 3in., or oak posts 4in. × 3in. and 9ft. 6in. in length, are firmly fixed and driven 2ft. into the ground, the lower ends being previously charred and coated with coal tar. This is the back line of posts. Six other posts exactly similar, but only 4ft. 6in. long, are fixed 18in. in the ground, forming the front posts of the house, the one rising 3ft. and the other 7ft. 6in. above the ground level. Two posts at one end occupy the centre and form the door-posts. On the six posts, both at back and front, a wall plate is nailed to receive the rafters, one of which springs from each of the front posts resting on the corresponding back posts.

Posts for orchard-house.

Wall plate.

963. The rafters are 14ft. long. A 9in. deal, 3in. thick, will make four of them. On the upper side of each rafter is nailed a slip of

½in. deal 1¼in. wide, which will leave ½in. on each side as rebate to receive the glass. The rafters so prepared are fixed in their place to the wall plates by having a piece cut out at each end to correspond with the angle of the back and front plates. They are then firmly nailed at back and front by strong spike nails, leaving a space between each rafter of 5ft. which is called a bay; this is filled up by smaller rafters or sash bars, of a size proportioned to their length and the use they are to be put to—vines trained to them requiring stronger bars. A piece of ¾in. deal board, 6in. wide, nailed along the top of each rafter, so as to be even with their upper edges, forms the ridge board, leaving a groove to receive the upper end of the glass. A similar piece of 1in. deal, 6in. wide, let in by sawing out a corresponding piece out of each rafter at its lower end will receive the glass and carry off the water. The placing of the glass is a very simple process. Beginning at the top, a plate of glass 20in. wide—each bay is divided into three parts by two intervening sash bars—is laid in the groove and fixed in its place by a brad driven into the rafter, a bed of putty being first laid; and so on till the whole is covered in, open joints in the glass being rather advantageous than otherwise, if not too wide. No putty is used in the laps.[1] The ends of the houses are fitted up to correspond with the roof, only that above the doorway a large sash is fitted in for ventilation. These sashes at each end, and the front or side sashes, are said by Mr. Rivers, the originator of houses of this description, to be quite sufficient, indeed he pronounces the ventilation perfect. Well-seasoned ¾in. deal, planed and jointed, nailed outside the posts, forms the lower part of the house.

The rafters.

Provision for glazing.

Placing of the glass.

Ends of the house.

964. In the back wall, sliding shutters, 3ft. by 1ft., will afford ventilation to the roof, and about 3ft. from the surface of the ground, two similar sliding shutters will ventilate the lower part of the house behind and on a level with them. Ventilation is secured by sashes, 2ft. 6in. wide, and running the whole length of the house under the wall plate; below these sashes the space is filled in with boarding well painted. In summer it is impossible to give too much air. The house is now complete, except the door, which must open inwards for obvious reasons, and may be half glass or otherwise, at the proprietor's discretion.

Mode of securing ventilation.

[1] In this kind of glazing the pieces of glass are laid continuously end to end or edge to edge in the rebate, there being no lapping of each pane over that which is immediately below it. Very little, if any, rain will make its way in between the joints.

965. Within the house a trench 18in. deep is formed, to which two steps from the outside will lead. This leaves a platform or border on each side of the trench, 4ft. 9in. wide, supposing the trench to be 3ft. wide. The back border requires to be raised 18in., and Mr. Rivers suggests that it would be improved by a second terrace behind the first, of 14in., supported by a 4in. brick wall, so that the back row of trees need not be shaded, while they are brought nearer the glass.

Arrangements within the house.

966. Such a house as this, when made by the amateur himself, should not cost more than £15. The borders should have a loose and open surface, formed of old lime, rubbish, and road sand, mixed with manure. This surface should be laid 4in. deep, and then the whole should be forked over and mixed with the soil to the depth of 9in. The structure when complete is admirably suited for the culture of vines, figs, peaches, and nectarines in pots. If a terraced border be made at the back, only two rows of trees could be placed, one in front of the other. In the front border two rows of trees should also be placed 3ft. apart, the trees in the front row standing each in front of the space between two trees in the row behind. Between the trees, and on either side of the central path, at the edge of the borders, strawberries in pots may be placed. For the treatment of trees under such conditions the reader is referred to the work already mentioned, which will give him all the information on the subject that he can require.

Cost of building.

Purposes to which it may be applied.

967. Fruit may be grown very successfully in what may be termed a fruit-shed. This may be made by covering in a portion of ground on each side of a garden walk with a span roof. If the walk thus treated be in the middle of the garden, with a wide border on each side of it, so much the better. The ends may be left open. The sides, which may be about 4ft. or 5ft. in height, may be enclosed with strong trellis-work, on which roses and other climbing plants may be trained. Provision may be made for glazing in the ends or filling them with trellis, if preferred. When this is done it is easier to protect the trees within the house by putting up canvas inside and next to the trellis in inclement weather.

Fruit-shed.

968. As full information will be given in the third part of "Every Man his own Mechanic" with respect to the details of the methods to be followed in building sheds and houses for various purposes out-of-doors, and of large size, we may confine our attention here to a brief description of one or two varieties of different kinds of buildings which may be found even in

Buildings suitable for gardens.

the smallest gardens, such as the Aviary, the Fowl-house, the Pigeon-house, and the Summer-house. To these another structure may be added, which can only be put up at a good distance from the dwelling-house, namely, the Pig-sty; and we will conclude the chapter with some remarks on rustic work suitable for certain positions, such as a flight of steps from a lower to a higher level, and rustic seats and fences.

969. An aviary is nothing more than a bird-cage on a very large scale. The elevation of an octagonal aviary is shown in fig. 503, and the plan both of the base and of the roof is shown in combination in fig. 504. A level piece of ground having been selected, or made if necessary, the area on which the aviary is to be built must be staked out with care. The amateur may make a four, five, six, seven, or eight-sided building as he may prefer; but he will find a six or eight-sided structure the most convenient and far prettier than the four-sided aviary in appearance. Supposing that it is decided to build an octagonal aviary, as shown in the annexed diagrams, a stout post must be reared in the centre, and eight posts of yellow deal, about 2½in. square, at the eight corners of the building. The bottoms of the uprights, which should be charred and well tarred, should be bedded in concrete, and the concrete bedding should be continued all round the site, as high as the ground level or a little above it. To these posts, at the very bottom, resting on the concrete sill, should be nailed stout inch boards to serve as a baseboard or plinth. These may be from 9in. to 18in. wide, according to the height of the house and the fancy of the builder. The baseboards may be recessed into the posts, or nailed on outside and neatly mitred at the corners. Above, round the top of the posts, a wall plate should be attached in a similar manner.

The aviary or bird-house.

Levelling and staking out area.

Construction of building.

Baseboards.

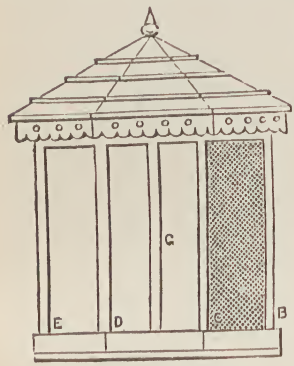


FIG. 503. ELEVATION.

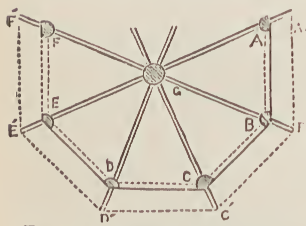


FIG. 504. PLAN OF BASE AND ROOF.

AVIARY.

970. The rafters for the support of the roof should rest one end on the uprights and the other end against the post C, which rises, as it has been said, in the centre of the building. This post may be dispensed with, if preferred, but in this case a block of wood must be introduced at the apex of the roof, against which all the rafters may abut, after the manner of rafters against the ridge-board or pole of a span roof. The ends of the rafters should project beyond the baseboard, so as to take the drip from the roof, beyond the outer surface of the baseboard. This is shown in the plan of the building in fig. 504, by the line A′ B′ C′ D′ E′ F′, which projects considerably beyond the line A B C D E F, which denotes the outer face of the baseboard. The roof may be weather-boarded or covered with boards placed edge to edge, vertically or horizontally, and covered in their turn with the ordinary roofing felt, or the Anglo-Danish Patent Asphalte Roofing Felt, which is noticed elsewhere, and is an excellent material for roofing purposes. To the ends of the rafters, a little within the edge of the roof, an ornamental barge-board should be nailed, as shown in the illustration (fig. 503). The roof should be surmounted at its very apex by a cap, on which a ball and spike is placed, which may be gilt. If considered desirable, drip from the roof may be prevented by running a light gutter of wood or zinc round the edge, and carrying the water to the ground through a pipe fastened against one of the pillars.

Rafters and roof.

971. With regard to the manner in which the sides are filled up, this must depend very much upon the situation of the aviary. If it be in a very sheltered spot, all the apertures may be closed with frames, on which wire netting has been stretched. Of these, one must be made to open and shut, but to guard against accidents it should be secured by a padlock. As it will be dangerous to throw this door open at all times for the admission of water, etc., provision should be made for its easy introduction by having a swing-flap at the bottom of one of the fixed panels, by means of which the bottom of the aviary can be reached easily. The birds will roost in the roof on perches running from the central pole to the rafters, and if there be no central pole, the timber against which the rafters abut should be carried low enough, say as far as the bottom of the ornamental barge-board, so as to carry the inner ends of the perches. If the situation be exposed, three out of the eight sides facing north-west, north, and north-east, or north-north-east, and east, may be permanently boarded up, and painted or coloured

Sides of structure.

Swing-flap at bottom.

Perches for birds.

Sides in exposed situation.

white inside, that the birds may be clearly perceptible against this background, which will show up their plumage. It will also be advisable to have frames covered with painted canvas or straw matting, etc., which may be placed against any of the wired sides to keep out driving rain or a boisterous rough wind. **Protection in stormy weather.**

972. The bottom of the aviary should be of concrete, sprinkled with sand, and a little lime taken from an old wall or any old building. Brackets and supports can be placed within, on which the birds may build and breed, but if possible these should be in such a position and so contrived that the birds may be out of sight, and in seclusion when sitting. It is scarcely necessary to say that the small-wired flap, as well as the principal means of entrance, should be secured by a padlock, and that one person only should keep the key and attend to the wants of the birds, as any carelessness in leaving the doors unlocked might lead either to the escape of the birds or the entrance of a cat, who would make short work of the rightful occupants of the aviary with its teeth and claws. **Bottom of aviary.** **Brackets, etc., for building.**

973. Anybody can make a rabbit-hutch, or a house for a guinea pig, so it will be sufficient here merely to mention these things, for, after all that has been said, the amateur, if he stands in need of them, will be able to contrive something better than the ordinary run of such structures for himself. Besides, if a man takes to keeping rabbits, he will do it for profit rather than for pleasure, and should manage his "warren" in such a manner that the rabbits may be kept in a state approximating as closely as possible to that in which they are when at liberty, and in a state of nature. **Hutches for rabbits, etc.**

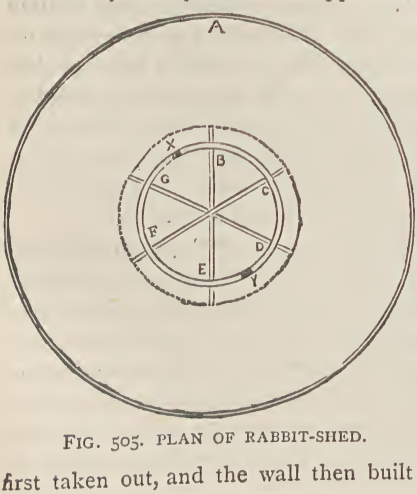


FIG. 505. PLAN OF RABBIT-SHED.

974. The accompanying diagram, fig. 505, will help the reader to some idea of the way in which rabbits may be kept in semi-liberty. The outer circle, A, represents a large circular wall of concrete, enclosing a space of 40ft. to 50ft. in diameter. To make this wall, a trench about 3ft. in width should be first taken out, and the wall then built against the inner circle, the **Rabbit-shed.**

space between the concrete and the outer circle being filled up with earth as the wall is carried up. It is necessary to excavate the trench of a much greater width than the wall which it is proposed to make, so that the workmen employed may have room to work. The wall should be carried as low as possible—to a depth of 20ft. even, if it can be done—to prevent the rabbits from burrowing under and upwards to the surface of the ground without the wall.

975. When the outer wall has been completed and brought within a foot or two of the surface of the ground, an inner wall should be made in the same manner, enclosing a pit about 10ft. or 12ft. wide, and about 5ft. deep, with a bottom of concrete. In the wall two or more holes should be made, as shown at X and Y, covered with trap-hatches that can be closed or opened from above at pleasure. In the inner wall uprights are embedded at regular intervals as at B, C, D, E, F, and G, just as in the aviary described above. These uprights support rafters butted against a pendant in the centre, and covered with thatch projecting for a foot or two beyond the inner wall. The eaves of the roof may be about 6ft. above the level of the ground. A rustic railing should be carried round the uprights, closing up five out of the six spaces between them to the height of 3ft.; the sixth opening should be filled with a gate, in keeping with the rest of the woodwork. Food may be thrown down to the rabbits when necessary. The rabbits will make their burrows in the earth between the outer and inner walls, entering them and quitting them by the holes in the inner wall. Whenever any are wanted for the table, or for market—for when rabbits are kept in this way they may be made highly remunerative—the opportunity must be seized to close the hatches, when a good many are out in the pit feeding, go down into the pit by the aid of a short ladder, and capture as many as may be required for slaughter. The rabbits should never be killed in the pit, but carried off and knocked on the head elsewhere.

Outer wall: its construction.

Inner wall, and trap-hatches.

Roof and railing.

976. It need scarcely be said that a light sandy soil, in which the rabbits can burrow readily, is the best suited for a rabbit-pit or warren of this kind. When it is considered how many tons of rabbits are sent over year after year from Ostend to this country, it is surprising that no attempt has been made to utilise some of the waste lands that may be suitable for the purpose in different parts of England for breeding, rearing, and sending rabbits to market on a large scale. A large expanse of heath-land might be laid out in squares of forty to fifty feet each way, by running walls of concrete

Soil suitable for rabbits.

across it at right angles to each other, and in the centre of each square space a rabbit-pit might be sunk, thus confining the rabbits in each pit to their own locality. In these days of joint-stock companies the idea is as well worth trial as most of the schemes for money-making that are brought into the markets.

977. Every one should keep fowls who can find room for them, and find or make time to attend to them properly. It is a moot point as to whether fowl-keeping pays or not. It all depends on the amount of care the fowls receive. If they are managed badly and not properly attended to, the fowls will contract disease and die; but if they are well cared for, the yield of eggs will more than pay for the food consumed, as the amateur fowl-keeper will find if he keep a careful account of his expenditure, and the value of his eggs at the market price. If it pays a small tradesman, such as a milkman, greengrocer, or even baker, to keep fowls, selling new-laid eggs at 1½d. each all the year round, except at Christmas, when he will get 2d. or even 2½d. per egg, it will surely pay the careful amateur, who will find on an average that the eggs he gets from his fowls, provided they be properly cared for, will not cost him more than 1d. each at the utmost.

Fowl-keeping profitable.

978. There are certain things to be observed in fowl-keeping that will go very far to promote and even secure success. If possible, let the fowl-house and run front the south, so that the fowls may have as much sun as possible. To promote laying in the winter-time, let the house be warmed artificially. Let the run be covered in so that it may be kept as dry as possible; let there be a plentiful supply of cinder ashes finely sifted, old mortar, and *sea sand*, if you can get it—if not, coarse road grit or fine gravel—scattered over the run; and lastly, let the droppings of the fowls be carefully removed from house and run every day, if there be time, but if not, at least every other day.

Things necessary to success.

979. So much for the keeping as far as everything except food is concerned. For the house and run, it should be covered in. This, however, applies to houses and runs of a small size in confined places, for when fowls can have a large run it is alike unnecessary and impolitic to put the run under cover. Still, even in this case it is well for fowls to have a covered shed in some part of the run, other than their nightly roosting-place, to which they can resort in wet weather, and under which they can be fed. In the house the main thing is to provide for ventilation, and a place in which hens can lay quietly, for when laying every hen likes

Construction of house and run.

extreme privacy. This is why fowls when at liberty "steal" their nests, as it is called.

980. The accompanying diagrams illustrate the construction of what may be called the Amateur's Suburban Fowl-house. It answers in every particular the requirements set forth above. In fig. 506 the plan of the fowl-house is exhibited. No dimensions are given, for reasons that have been already stated; but as suburban gardens and the yards that do duty as gardens

Amateur's Suburban Fowl-house.

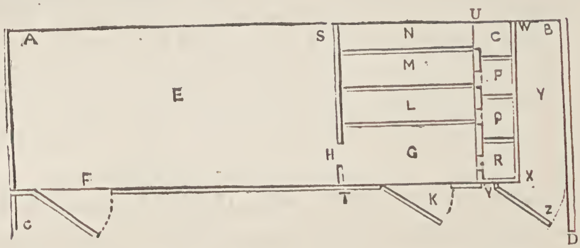


FIG. 506. PLAN OF AMATEUR'S SUBURBAN FOWL-HOUSE.

are generally narrow, the fowl-house should be about 6ft. or 7ft. wide, and extend along the whole length of the wall at the bottom of the garden, or along so much of either side as can be fairly given up to it. In the

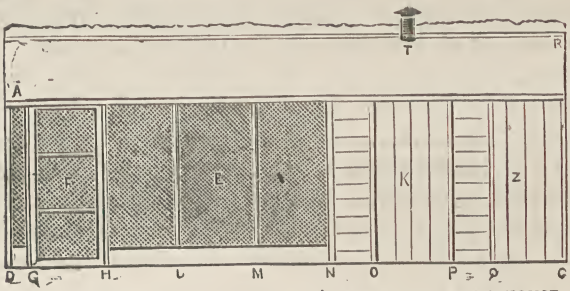


FIG. 507. ELEVATION OF AMATEUR'S SUBURBAN FOWL-HOUSE.

plan the house is supposed to be built across the bottom of the garden, extending from side to side. In fig. 506, therefore, which is the plan, A B is the bottom wall of the garden, and A C, B D parts of the side-walls contiguous to it. Three out of four sides of the house are provided for at once, and the expense of building is reduced to a minimum, the amateur builder being only called on to furnish the front, the roof, and the partitions and fittings within.

Plan of structure.

981. The plan of the yard is thus arranged: E is the run, entered from the garden or court without by the wire door F; a partition S T

divides the run from the roosting-place G, to which the fowls gain access by a hole cut at H, before which there is a hatch or trap-door that can be closed at pleasure; as, for example, to shut the fowls up in the yard E, while the roosting-place G is being cleaned out, for which purpose it is entered from the court by the door K. The roosting-poles are shown at L, M, N, as they would appear looking down on them through the space occupied by the roof. From the roosting-place access is gained to the nests, O, P, Q, R, through holes cut in the partition U V, which divides the roosts from a small enclosed place Y, into which the nests project. This will be better understood from figs. 508, 509, of which fig. 508 shows the face of the partition U V, as seen from the roosting-place G. The spaces occupied by the nests—namely, O, P, Q, and R—are shown below with the holes leading into them, which should not be cut larger than just sufficient to admit a hen. At L, M, and N brackets are shown with semicircular notches cut into them, into which the roosting-poles L, M, and N are dropped, parallel to the wall of the house at the back. The fowls enter the house at H, and hop from pole to pole until the topmost one is reached. The poles should be rough round poles with the bark on; clothes props cut to the proper length are the most suitable. The claws, or rather toes, of the fowls clasp a round rough pole far more readily than a smooth pole, and to give them a square rod to roost on is a downright cruelty, for the edges of the rod hurt the fowls' feet. The poles should be movable and not fixed, that they may be taken down and washed occasionally. It will be understood that brackets similar to those shown at L, M, and N must be fixed in similar positions along the inner face of the partition S T, to receive the other ends of the poles. When the trap at H is closed, the door at K can be opened, and the amateur can enter the roosting-place, remove the poles, clean out the house, and whitewash it when necessary with ease to himself and without disturbing the fowls which are in the run at E.

General arrangement of yard.

Poles for Roosts.

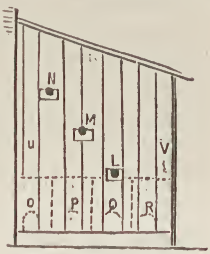


FIG. 508. ELEVATION OF PARTITION.

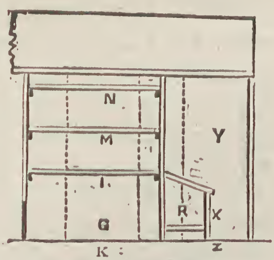


FIG. 509. INTERIOR OF ROOSTING-PLACE.

982. In fig. 509 the interior of G is shown, the front being removed

and the position of the door K indicated by the dotted lines; the poles L, M, and N are shown in the drawing, and the brackets on which they rest are indicated. In this figure the interior of the chamber Y is also shown. This is contrived in order to allow the owner of the fowls to prevent any one but himself from getting access to the nests, which he can do by keeping the door Z locked. The nests O, P, Q, and R, as shown in plan in fig. 505, are divided from each other by partitions; the board in front, W X, shown at X in elevation in fig. 509, should either take out or be let down on hinges attached to the bottom rail, so that the nests may be more easily cleaned out at intervals; they are covered in by a slanting frame A, made in separate pieces so as to form a lid over each nest. Of course the owner will endeavour to choose a time for the inspection of the nests when the hens are in the run, but if a hen should be in the nest at any time when the lid is raised it can be shut down quickly and noiselessly so as to disturb the hen as little as possible. On the principle of killing two birds with one stone, the little chamber Y may be used as a tool-house, or as a place for keeping odds and ends that are useful at times in the garden.

Interior of roosting-place, etc.

Position of nests.

983. The method to be followed in arranging the fowl-house will be clear enough, and it only remains to explain its construction as far as may be necessary. The amateur is recommended first to make a strong frame for the front, as shown in fig. 507, consisting of two rails A B, C D, one running the whole length of the house at the top, and the other at the bottom. If made of two pieces, the pieces must be scarfed together. The rails A B, C D must be connected by strong uprights A D, B C, which must be fastened into the wall; the most convenient way of proceeding will be to lay the bottom rail C D in position, and then to fix in it the uprights at the ends and the intermediate uprights at G, H, L, M, N, O, P, and Q, which, it need scarcely be said, should be mortised into the rail. Corresponding mortises should be cut in the rail A B, which should then be dropped on to the uprights and wedged up. Supposing the height of the front to be 6ft., and the wall at the back 8ft., a wall plate should be nailed to the wall about a brick or two bricks below the top, and rafters laid from the wall plate to the rail A B, which will keep the front immovable in its proper position.

How to build the house.

Frame for front.

984. Before putting on the roof it will be desirable to put up the partitions, shown at S T and U V in plan in fig. 506, to put up the roosting-poles, and construct the nests. Then the wired door F may be hung, and the wire netting stretched over the space between A D and

the upright G, and from the upright H to the upright L, from L to M, and from N to O. The spaces between the uprights N O and P Q must be boarded up, after which the doors K, Z must be hung.

Partitions, roosting-poles, and nests.

985. Lastly, the roof A B R S must be boarded over and covered with Anglo-Danish Roofing Felt. A gutter should be placed along the whole length of the roof from A to B to prevent drip, and the water should be carried off from the gutter by a pipe running down the wall on either side, and connected with a pipe leading to the drains of the house, unless it be desired to store the water for the use of the house and garden. If a gutter be made in the way described in Part III. the front may be finished with a crest-board which will add much to the appearance of the house. To insure ventilation a round zinc pipe about 3in. or 4in. in diameter, covered with a shallow conical cap raised above the pipe on suitable supports, and extending over and beyond the opening to keep out rain, should be let into the roof at the back in the middle of the roosting-place G. The air that is warmed by coming in contact with the closely-packed bodies of the fowls will be carried upwards and out through the ventilator by the cold air that enters at H. The doors at K and Z should be ledge doors and hung on T hinges; the wire door F may be hung on butts. All the doors should be fastened by staples and padlocks, one staple being in the door, the other in the hanging-post, so that the hoop of the padlock may be passed through both and secured; if, however, all the doors are not fastened in this way, it is desirable that the door Z at least should be kept under lock and key to secure the eggs.

Roof and gutter.

Ventilation.

Padlocks to doors.

986. Although this is a work on building and carpentry as far as it concerns the amateur, two or three hints on feeding fowls may not be altogether out of place. Avoid as much as possible throwing corn, etc., on the surface of the ground that forms the run. Many entertain the idea that it is better to do so because the fowls when picking up grains of corn, rice, etc., from the ground, also pick up grit and sand necessary for the proper trituration of the food in the gizzard; the fact is lost sight of that they are prompted by nature to supply themselves with all that is necessary for this process, and that they will pick up sand and small sharp stones irrespectively of their food. This should be kept as much as possible from contact with the soil of the run which is fouled with the droppings of the fowls, and should be frequently dug over, and occasionally removed altogether to make room for fresh soil. Soft food, as boiled rice, etc., from the

Hints on feeding poultry.

house must of necessity be thrown on the ground, for if it be put into the run on a plate or even in a shallow tray the fowls will scratch it out and scatter it on the earth. Green food, however, should be tied together in a bunch and suspended about 12in. above the floor of the run, while corn should be given in a self-supplying vessel.

987. Such a trough the amateur carpenter can make for himself. He will find it useful for fowls as well as pigeons; it is on the same principle as the stone drinking fountains in which water is placed for fowls. A section of this feeding trough or box is shown in fig. 510; it should be about 2ft. long, and from 5in. to 6in. wide if many fowls are kept; but if there are only a few fowls in the run it may be smaller. A B represents the back, and E F the front; the two sides or ends are of the shape shown by A C D F E B. The sides must be nailed to the back and front; and the bottom B E then put on. Two ledges should run along the whole length of the bottom in front and behind at E and B to keep the trough from standing on the ground. The board C D is placed between the ends in the position indicated, and the ends are nailed to it. Over the top a cover A C is fitted, attached to the back by hinges. The space between A B and C D is then filled with corn, and as much as will is allowed to pass into the trough below through the narrow opening at D, which need not be more than ½in. in width. The feeding trough is then placed in the run, and as the fowls pick up the grains of corn in the trough others fall through the slit D to supply their place. In using a contrivance of this kind all that is necessary is to inspect the trough at regular intervals with a view to replenishment. The fowls can help themselves whenever they require food; they will never be impatient for food as they are when there is any neglect in feeding them at stated times, and there will be no waste as there often is when corn is scattered by handfuls on the ground and trodden under foot by the hungry birds in their eagerness and haste to fill their crops.

Useful feeding trough.

Its construction.

FIG. 510.
FEEDING TROUGH FOR FOWLS.

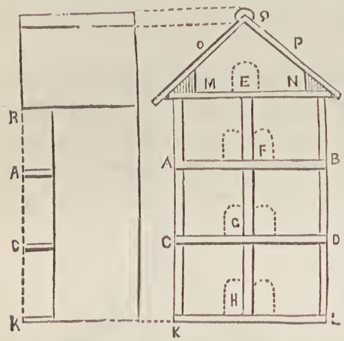
988. The form and construction of the pigeon-house will vary in accordance with the number of pigeons kept and the requirements of the amateur with regard to picturesqueness of appearance. The rule in building or making a pigeon-house is simply this, that for every pair of pigeons that is kept there must be a separate apartment. Thus, if one pair of pigeons is kept, a little box one foot every way with a slant roof above it to keep off the rain, and

The pigeon-house.

a ledge in front of the entrance on which the birds may settle, will be sufficient, but for more birds more room will be wanted.

989. There is so little difficulty in building a pigeon-house that a diagram is almost unnecessary. Suppose that the amateur builder wants accommodation for six pairs of pigeons, and that he has a box three feet long, two feet wide, and one foot deep. This will serve as the carcase of the building. If he has not a box or a case closely approximating to this in size, he can make one. The interior must be divided into six compartments of equal size, by one partition from end to end, lengthwise, and two in the contrary direction. For such a house as is now under consideration as shown both in front elevation, but with the boarding in front removed, and in side elevation in fig. 511, it will be better to put the shorter partitions across the box as floors for the compartments as at A B, C D, and subdivide the divisions thus made by the vertical boards E F, F G, and G H. The floors, as we may call them, should project beyond the sides of the compartments as at A and C in the side elevation, and the bottom board K L should project in the same manner as at K. If the amateur is converting a case or box into a pigeon-house, he must nail on a ledge to the bottom K L, securing it by suitable supports, such as cleats nailed on below to the bottom, and projecting outwards to a sufficient distance. Two pieces of wood, M and N, are nailed to the top to afford a bearing for the boards O, P, that form the roof, a cap Q being nailed over the joint at the top. As it is a pity to waste the room in the roof, this can be turned into another compartment. When the front is boarded over, holes from 3in. to 4in. wide, and about 6in. high, should be cut for the admission of the pigeons. The holes should be made in the centre of the front, at E, F, G, H, as shown in the diagram. To prevent one couple from interfering with the other on the same level, which they may do owing to the doors being in such close proximity, it is better to bring out the central partitions to the outer edge of the ledges, as shown by the dotted line K R, and it will furnish additional and desirable protection to the interior if the sides of the house be brought out to the same line.

Construction of ordinary house.



SIDE ELEVATION. FRONT ELEVATION.
FIG. 511. PIGEON-HOUSE.

Floors of boxes.

Roof and cap.

990. The house that is represented in fig. 511 is not by any means remarkable for its picturesque appearance, but it is only the principles of construction that the figure is intended to show; ornamentation in this case and determination of length, breadth, and number of compartments must be left to the amateur. Pigeon-houses are fixed to the sides of houses and stables, or on the top of a pole to be out of the way of cats, but in such positions it is difficult to get at them when the "squeakers," as young pigeons are called, are wanted for that most delicious preparation known as pigeon-pie. There is an arrangement, however, by which a pigeon-house, even though it be perched at the top of a pole, may be brought within reach of the owner without the necessity of climbing a ladder.

Pigeon-house should be easy of access.

991. The annexed diagrams will show the *modus operandi* to be followed, and the plan on which the house is constructed. The only thing against the plan is that the young pigeons may sometimes fall into other hands than those of the legitimate owner. A sound, strong flour barrel, which can be purchased for 1s. 6d., or 2s., must be procured, and a pole about 25ft. high, which should be sunk at least 5ft. in the ground. A hole must be made in the top and bottom of the barrel, into which a pipe of sheet-iron or strong zinc must be inserted, the object of this being to allow the tub to be worked freely and without hindrance up and down the pole. The sides of this pipe are shown at A, B in fig. 512, which represents a section of the tub, pole, and covering, and at G in fig. 513, which is a plan of the tub and the interior and exterior fittings. These consist of transverse partitions, two in number, dividing the tub into three chambers; and vertical partitions, as at A, B, C, D, E, F, dividing each chamber into six compartments. It will be understood that the head of the tub must be removed, and the interior built up from the bottom tier by tier, after the insertion of the central pipe. The head must then be put on, and the

How to make it so.

Pipe in centre of tub.

Construction of boxes.

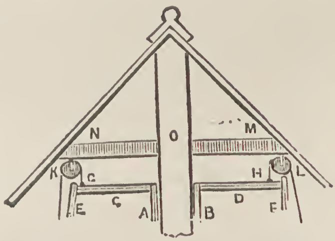


FIG. 512. VERTICAL SECTION OF PIGEON-HOUSE.

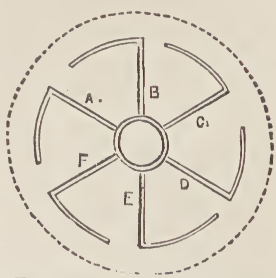


FIG. 513. TRANSVERSE SECTION OF PIGEON-HOUSE.

entrances to the compartments, previously marked out, cut out with a keyhole saw. Ledges shown by the dotted circle in fig. 513 should be fixed round the tub on a level with the floor of each chamber, supported on small angle irons screwed to the sides of the tub. Brackets of wood may be used instead of angle irons, but the latter will be found more convenient and look lighter.

Entrances and ledges.

992. In fig. 512, C D represents the top of the tub and E F the sides. In the top of the tub two iron eyes, G H, are screwed, through which hooks are passed, attached to the ends of two ropes that pass over pulleys K, L, screwed into the transverse timbers, M, N, which are mortised into the pole O, and with others help to sustain the conical roof which covers the tub when pulled up close to it, and protects the tub and its inmates from the rain. The roof should extend well over the tub and beyond it even more than is shown in the drawing, because the centre of the tub is wider than the top and bottom, and it is necessary that the drip from the roof should fall clear of it. It will be seen that the tub can be lowered and raised conveniently at pleasure, so that the young birds can be taken and old nests removed, and the tub cleaned at any time. When raised to the top of the pole the ropes should be wound round cleats nailed on to the pole near the bottom to receive them.

Arrangements for raising and lowering tub.

Construction of roof.

993. In a large family, all things permitting, it is very desirable to have a couple of nice pigs in a suitable pig-sty, or "pig's-loose," as it is termed in Devonshire, for more reasons than one. Firstly, where many are housed together under one roof, it follows of necessity that there must be much waste in the strippings of vegetables, when in preparation for table, and much that must otherwise be thrown away. Secondly, pork from badly-fed pigs is more or less unwholesome or undesirable as food; so by keeping a couple of pigs, which may be killed when they have attained the weight of six or eight score, all the waste is saved and turned into wholesome meat, and those who have fed the pigs have the satisfaction of knowing that the pork which is placed before them is as good as it is possible for pork to be. A pig is a capital machine for converting what would otherwise be useless, valueless offal into a substance worth from 6d. to 9d. per pound. Of course barley-meal, sharps, and other things must be given to the pig if it be desired to have good firm meat, but the value of the animal when dead will quite cover the outlay for food of this kind given in conjunction with wash and waste.

Keeping pigs.

994. It is desirable that the pig-sty should be at some distance from the house, and that it be kept well drained and as clean as possible. When the wind blows in the direction of the house, and from the quarter in which the pig-sty stands, the odour that the wind brings with it is anything but agreeable if the sty has not been properly kept. By proper drainage and ventilation, however, it is possible to keep a pig-sty as sweet as a stable, or any other house in which animals are kept. In the accompanying diagrams the plan, section, and elevation of a small but very convenient pig-sty are shown.

Situation of pig-sty.

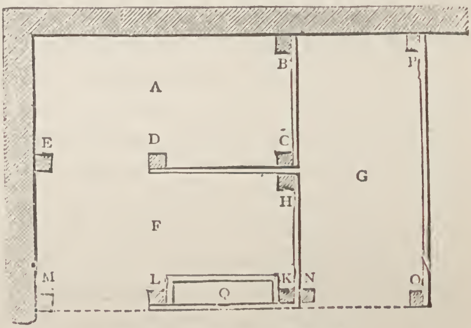


FIG. 514. PLAN OF PIG-STY.

Fig. 514 exhibits the plan of the structure, which is supposed to be built in the corner of a garden, the walls that form the angle supplying the back and one side of the structure. Looking at the arrangement of this figure, we see that A, the innermost part of the space, is set apart as the house or bed of the animal. To make this part of the building, four stout posts are set in the ground at B, C, D, and E, the space between D and E being left open to give the pig access to the yard F. There should be a low or swing-board door at B C, through which the straw and manure that accumulates in the bed may be drawn into the manure pit G, which is just outside this part of the building and the yard as shown in the plan. The yard F and the manure pit G are enclosed by means of posts and rails. Between H and K there is a swing-board at the bottom of the fence as between B and C, or the whole space may be filled with a gate opening into the manure pit, or a piece of fencing removable at pleasure. Between K and L is the trough Q, of which more will be said directly, and between M and L a strong gate. There is also a gate between N and O by which access to the manure pit can be obtained from the garden, and the space O P

Plan of structure.

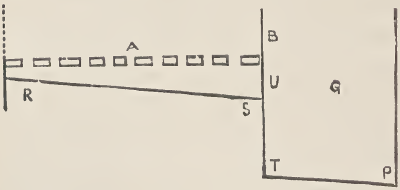


FIG. 515. SECTION OF PIG-STY AND MANURE TANK.

may be closed up with railings or a boarded fence against which a fruit tree or climbers may be trained. The bed should be raised about 6in. above the ground level, and both bed and yard should have a good fall towards the manure pit. The bottom of the pit should be below the level of the yard and house, and should be lined with concrete to prevent anything that drains into it from bed and yard from being lost by soaking into the soil. This will be seen by examining fig. 515, which is a section of the building lengthways. In this A shows the bottom of the bed formed of board battens placed at a sufficient distance apart to allow all moisture to trickle down to the concrete bottom R S, which also shows the slope of the yard. At B is the swing-board through which the straw may be drawn. The moisture escapes into the pit at U, which may be partly closed, leaving a long opening about 1in. or 2in. wide for the exit of the water. The bottom of the manure pit is shown at T P. The manure pit should be made to slope from all sides to the corner P, where a small pump may be placed in order to draw up the liquid manure that will accumulate there. Fig. 516 is the front elevation of the whole structure. As the pig is not a very tall animal its bed or sty does not require to be very high; it should, however, be high enough to allow any one, who requires to do so, to enter it in a stooping posture. Rafters may be put about 5ft. above the floor of the bed, and the space between the rafters (which may be boarded over or covered with a wattled hurdle) and the sloping roof which inclines from the wall at back towards the yard, may be used as a place of storage for straw, etc. The roof, if not tiled or slated, should be boarded and covered with Anglo-Danish Patent Roofing Felt, or Pasteboard, or with the ordinary roofing felt, which should be coated with tar and lime, applied when hot, and covered with finely-

Bed and drainage.

Fig. 516. FRONT ELEVATION OF PIG-STY.

Rafters and roofing.

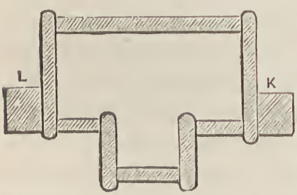


Fig. 517. PLAN OF PIG'S TROUGH.

sifted sand before the tar and lime has had time to cool. If wood be used entirely in building the front of the place where the litter is kept, the front of the bed also should be weather-boarded with stout boards.

995. It is now necessary to describe the feeding-trough Q, which is placed between K and L. This is of a convenient, though peculiar, construction, being made in such a way that the food can be emptied into the trough without going into the yard for that purpose. The trough is a fixture consisting of a bottom, two ends, and two sides, arranged as shown in plan in fig. 517, and in section in fig. 518. The wood used for the trough should be elm, about 1½in. in thickness, and the bottom and sides should be grooved into the ends. When finished the whole is firmly fixed between the posts L and K, as in fig. 517, the ends being nailed to these posts. A swing-board X (fig. 518), which is hinged to a rail Y running from the post L to the post K, can be lifted up and held by a hook and eye against the boarding above when the food is poured into the trough; when in its place it can be secured with a staple and bolt. The aperture for pouring in the food is not so long as the front part of the trough in the illustration, but the amateur may save himself some trouble if he extends it the entire length from post to post, taking the precaution to put in three or four bars on each side over the top to prevent any attempt on the part of the pig to struggle through the opening when the flap is raised.

The yard and its fencing.

Feeding-trough.

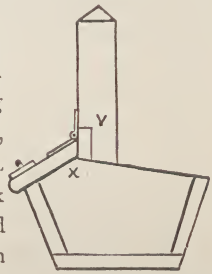


FIG. 518. SECTION OF FEEDING TROUGH.

996. It may be that most amateurs will find it more convenient to make the pig-sty of wood than of other materials, especially as the doors must be made of wood, and the trough also. It must, however, be remembered that local position will exert a considerable influence on the material and manner in which the structure is made. In Devonshire, for example, the sty, and in many cases the yard also, is formed of rough irregularly shaped "pitching stones," obtained from some neighbouring quarry that yields masses of laminated stone, from which rough slabs are split, that are set on end in the ground and well rammed. Lascelles' Patent Concrete Building Slabs also present a useful material for structures of this kind, and, being regular and uniform in shape, present none of the ugly irregularities of outline that are exhibited by the stones. These slabs, and the manner in which they are used, will be described at length in Part III.

Materials for building must depend on locality.

997. In dealing with the pig-sty as above described and figured, there is no structural difficulty whatever; all is plain sailing. The posts for the bed and yard are set in the ground and rammed tight, a rail having been mortised between D and E at the level of the floor, and another to receive the floor of the upper compartment in which the litter is stored. Rails are also mortised between B and C at the floor level, and again between B and C and C and D to receive the rafters of the litter compartment, and a third rail must be mortised between B and C to which the swing board may be attached. Along the tops of these posts a wall plate is fixed to receive the ends of the rafters in front, those behind being supported on a wall plate nailed to the wall that forms the back of the pig-sty. The floors of the bed and yard may be paved or made of concrete, with a fall to the manure pit, so that all liquid matter may drain into it. In making the yard, rails are mortised into the posts G and F to receive the palings, and G is the hanging-post to which the gate of the yard is hung, and E the falling post. With regard to the aspect of the pig-sty, it should, if possible, front the south, for pigs thrive all the better in a dry and warm situation. A pig likes to be kept high and dry out of the wet; it is altogether a mistake to suppose that they prefer to be knee deep in slush and filth, as they are too often allowed to be.

No structural difficulty in pig-sty.

Pigs should be kept dry.

998. The construction of the summer-house depends entirely upon the position in which it is placed and the purposes to which it is put. It is generally intended for nothing more than a cool and pleasant retreat in summer time, and so situated that it may command a good view of, and form a picturesque object when seen from, the house; if the garden be small, or if it be placed somewhere in extensive grounds, a spot is chosen with a pleasant aspect and outlook over the surrounding scenery. In such cases the summer-house is built open on all sides, or at all events on those sides which are turned towards

The summer-house: its position.

FIG. 519. HEXAGONAL SUMMER-HOUSE.

the best point of the landscape ; but if it be in a garden removed from a house, and is used as a place of security for garden tools, etc., it must be enclosed on all sides, and provided with a door and windows.

999. A pretty summer-house is presented to the reader in fig. 519 ; it is one which he may easily make with the exception of the roof, for which he must call in a professional thatcher, or make it of wood, covered with felt, and guarded at the angles, where the ends of the roofing boards meet and rest on the rafters, with rounded caps, surmounted at the point in which they all meet by a conical cap and ornament. Houses such as these are best made hexagonal or octagonal in form : the summer-house shown in fig. 519 is hexagonal, but the plan of a house of a similar kind shown in fig. 520 is octagonal. In either case, the method to be followed in its construction is the same, the chief point of difference being in the number of the posts that support the roof. First of all, let the amateur builder mark out a regular hexagon or octagon of the size required, and at each angle sink a stout fir pole ; if the bark be left on the poles it will add to the picturesque appearance of the building. When the posts have been well rammed in, let in blocks of wood, bevelled at top on the outer edge, and about 6in. in width, between the posts, and nail the ends securely to the posts with spike nails. Between the posts that form the entrance a broader piece may be placed, forming a step that projects beyond the face of that side of the building. The floor of the building may now be formed by paving the area left within these pieces with blocks of fir, made of fir poles, cut transversely, the interstices between the larger pieces being filled with smaller blocks, the whole being beaten level, and the small spaces that are left being filled with sand and cement, wetted and mixed together until it is of the consistency of thick cream, and worked down with a broom between the joints. Such a floor is warmer to the feet than one entirely of concrete. Next cut the poles level at the top, if they are not already so, and, to keep all firm, bind them together with a wall plate to receive the rafters, six or eight in number as the case may be, running from the wall plate to the apex of the building.

Hexagonal summer-house.

How to build it.

The posts: how to fix them.

Floor of building.

Wall plate for rafters.

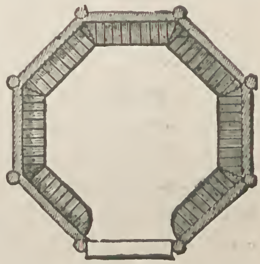


FIG. 520. OCTAGONAL SUMMER-HOUSE.

1000. The construction will be best understood on reference to fig. 521, in which A B is a post of the building; C, a block, or section of block, let in between post and post; E, the wall plate at top; F, a rafter; and G, G, transverse pieces nailed from rafter to rafter to support the thatched roof. The rafters are all butted against and nailed to a hexagonal or octagonal block as the case may be. Notched into the pillars, and resting on the block C, is a cleat H, nailed firmly to both. Another cleat, K, is notched in above in the same way, about 14in. or 15in. above the level of the floor D. This cleat serves to sustain the rails as at L, which rest in front on an upright, and sustain other rails parallel to the sides of the building, which form the seats; and the building below is closed in with fir poles, sawn in half, and nailed to the cleats or rails H, K. A similar half-piece is notched into the posts as shown at M, and another as at N. and to these the pieces are nailed which form the rough and open lattice-work at the sides above the seat. The rail at N is formed of a *whole* length of fir pole, not sawn in two, but cut out in such a manner as to form a cap to the lattice-work as well as a cleat to which the upper ends of the cross bars are nailed. The cross bars will present a better appearance if they are halved into each other. With the aid of fig. 520 any amateur builder may make a summer-house of this description. In some positions it may be desirable to close in three or more of the sides of the building. This may be done by carrying the fir poles, sawn in half longitudinally, to the wall-plate, which in this case should be put inside instead of outside, as shown in the figure at E. The sawn poles may also be substituted for the lattice-work, and carried up to the rail N, the position of which should be reversed, or a square cleat notched into the posts, and a half-piece of sawn pole nailed as a cap over this rail and the ends of the vertical half-poles. In the plan of the octagonal summer-house shown in fig. 520 the seat is formed of these half-poles resting on a rail as at K in fig. 521, and others in the same position, and rails running on the tops of the legs that sustain the front of the seat placed round the interior of the building.

Details of construction.

Closing in sides of building.

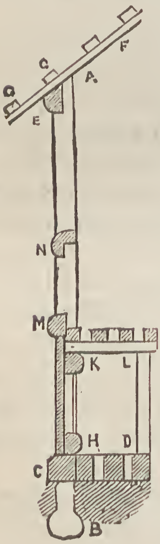


FIG. 521.
CONSTRUCTION OF SUMMER-HOUSE.

1001. The style of the summer-house just described is closely akin

to what is usually called "rustic work," inasmuch as timber in its natural state is introduced into its construction. Properly speaking, rustic work includes all kinds of articles and appliances in which timber is used in its natural form, and always in the shape and sometimes in the condition in which it lived and grew, namely, with the bark on, and nothing removed from it except the smaller branches and twigs which have sprouted from it. The summer-house was a piece of composite work, being partly made of fir poles, with the bark on, sawn in half, and partly of pieces of wood cut into the required shape by the joiner; but yet it approaches so closely to rustic work pure and simple that it may be reckoned as such.

Rustic work: what it is.

1002. Rustic work is chiefly applicable to the making of seats for the garden which are always exposed to the weather, for rough fences and gates where irregular work is more in harmony with surrounding objects and scenery, and for approaches and ascents by means of steps from lower ground to higher, both being disposed in the form of terraces. For such kind of work as this the loppings of oak trees are most suitable, as their crooked shape—the parts of oak boughs being bent to each other at angles varying from 90° to 135° or thereabouts—renders them well fitted for working up into garden seats, fences, etc. This, indeed, may be termed the carpentry of rustic work, while its joinery consists in the neater work of coating foundations of deal and other kinds of wood, carefully fitted together, with virgin cork, split poles, and sticks of ash, hazel, etc., to form ornamental brackets, flower-boxes, and flower-stands, as already described.

Things that may be made in rustic work.

Its carpentry and joinery.

1003. With two or three examples of carpentry in rustic work, we may fitly bring this chapter to a close. After a few remarks on the selection of wood suitable for the purpose, and the methods to be followed in putting the pieces together, we will give examples of a garden seat for three or four persons, a chair for one person only, a small garden table, and a low flight of steps or rustic stairs.

Examples of rustic work.

1004. For framing together pieces of wood in their natural state, halving together and the mortise and tenon joint must be resorted to. It must be remembered, however, that the pieces which are to be joined together are not square but *round*, and that some modification of the process above mentioned must be made in order to ensure accurate fitting together and general neatness in the appearance of the work when it has been turned out of

Halving and mortise and tenon joint.

hand. What is meant by a modification of the processes of halving timbers together and making the mortise and tenon joint will be seen from an inspection of fig. 522. In ordinary work, when two pieces of wood, each of which is rectangular in section—like the arms of a cross, for example—are halved together, a notch is cut in each piece to the extent of half the thickness, and the pieces thus prepared are fitted over and into the other ; but when two pieces of round wood are to be joined in this way, a little consideration will show that it is not possible to proceed in the usual way, and that a semicircular notch, as at A, must be made in one piece—generally that which assumes a horizontal position in the work—and the other piece dropped or fitted into the rounded notch thus made. When it is absolutely necessary to cut a notch in both pieces, it is better to make the width of the notches less than the diameters of the pieces to be fitted together; and having done this *pare away the sides* of each piece that drops into the notch in the other, so as to allow of one piece entering the other without difficulty, and prevent the parts that are left unfilled on each side from showing too conspicuously. The mode of doing this is shown at D ; the object being to make a neater halved joint. When one piece of rounded wood has to be nailed to another or against another, the joint being pretty well out of sight, or when a piece of wood has to rest on a transverse rail whose surface is flat and not rounded, the end may be cut as shown at B ; and when pieces have to be cut to fit into the corners of other pieces joined at right angles to each other, the ends should be cut away to fit with accuracy against the rounded parts of the pieces as at C.

Modifications of these processes.

Directions for notching.

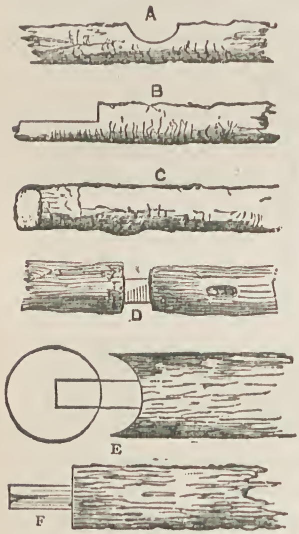


FIG. 522. JOINING TIMBERS IN RUSTIC WORK.

In making a mortise and tenon joint, the shoulder of the tenon should be rounded or hollowed out as shown at E; and unless it is necessary for the sake of making the structure as strong as possible to have a tenon as wide, or nearly so, as the diameter of the wood, the tenon may be made in the form of a pin, as shown at F; the mortise for its reception being bored with a stock and bit or auger instead of being taken out with a chisel. Great

Shoulder of tenon, etc.

nicety is required in making a close and accurate joint, but a little practice will enable the amateur to do this without difficulty.

Suggestions for framing rough timbers.

1005. Pieces of round wood framed together are shown in figs. 523, 524, which will serve as suggestions of the methods to be followed in forming rough fences, or the ends of rustic seats, or the supports of fixed garden tables. In fig. 523 the transverse pieces are fitted to the upright on the right by semi-circular notches cut in either one or the other, as may be preferred ; but to the left-hand support the rails have been fitted by taking out a notch in each, just one quarter the diameter to the wood, and fitting them one into the other, or by the mortise and tenon joint, as shown at E in fig. 522. In fig. 524 the crossed timbers forming the supports should be framed together by notching, as shown at D in fig. 522, and the trans-

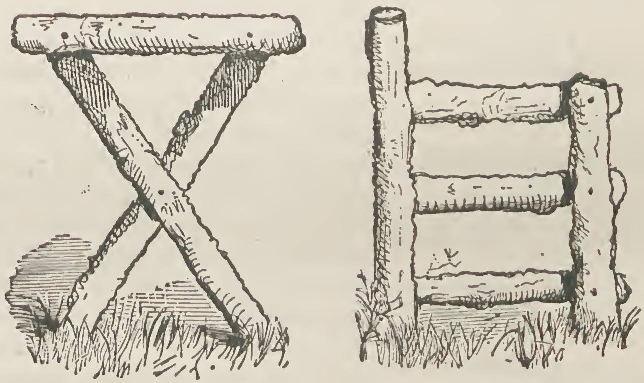


FIG. 524. SUPPORT OF TABLE. FIG. 523. END OF RUSTIC SEAT.
FRAMING IN RUSTIC WORK.

verse rail halved into the ends of the supports, or very nearly so ; the ends of the supports being cut as at B in fig. 522. The halving together in this case may be done in the ordinary way, as the joint is concealed, in the case of a chair or table, by the rails that form the seat of the one, or the slab that forms the surface of the other.

Garden furniture.

1006. From the consideration of the method in which pieces of timber used in rustic work are framed together, we may pass to the promised examples of the garden seat, chair, and table, merely observing that, in making garden furniture of this description, the amateur carpenter must work for the most part without a working drawing, as the work to be done is irregular, and it is necessary to select such pieces as may be suitable for his purpose ; first for the frame, and then for the filling in, taking care that pieces

which occupy similar positions match as closely as possible without being symmetrical or exactly alike.

1007. In the examples chosen for garden seats the work is as straight as possible, and may be executed with poles of fir or larch, ash, alder, or hazel. For the bench shown in fig. 525, stout pieces must be selected for the uprights at the four corners, into which should be framed the rails that form the front, back, and ends of the seat. The leg or support in the centre of the front should be mortised into the rail that rests on it, and at the back the rail should be halved into the two supports or uprights between those at the ends, and these uprights should extend to and rest on the ground, though not shown as doing so in the illustration. The topmost rail in the back is halved into the uprights; the central rail consists of pieces mortised into the uprights. The ornamental work is formed by bending pieces into the angles of the framework already formed, and strengthening them and retaining them in their places by cross-pieces issuing from the angles made by the smaller vertical pieces of the back, with the rails at top and bottom. The ornaments in the angles of cross-pieces and elsewhere may consist of large fir cones, or of round pieces of wood, cut transversely from poles, and fixed in their places, as the fir cones must also be fixed, on stout wires. The arms at each end are formed of pieces of poles put on in a slanting direction, and supported in the middle by uprights from the end rails of the seat. At the sides, the uprights are connected near the bottom by horizontal rails, for which diagonal braces are substituted in the front. The seat is of split poles, nailed at the ends to the front and back rails of the seat, and in the middle to a flat central rail running from one side of the seat to the other.

Garden seat.

Method of construction.

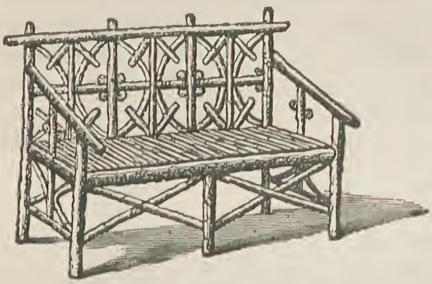


FIG. 525. BENCH FOR GARDEN.

Ornamental work.

Arms of seat.

1008. In fig. 526, which represents a garden chair for one person only, a round piece of wood is selected for the seat, and into this three legs are inserted, which are connected by diagonal braces. The back is formed of three pieces securely spiked to the seat, into which they may be notched, and

Garden seat for one person.

connected at the top by transverse rails. Support is given to the back by braces attached to the side pieces of the back at one end, and to the sides of the chair at the other. The seat is finished by covering the foundation with split hazel sticks, and nailing a hoop of split hazel round the edge. Amateurs will find wooden hoops that have been used for casks very useful for work of this kind, as by using them they are saved the trouble of splitting the sticks, which is by no means easy work. They can be got at the cooper's sometimes, and almost always of the wholesale provision merchant.

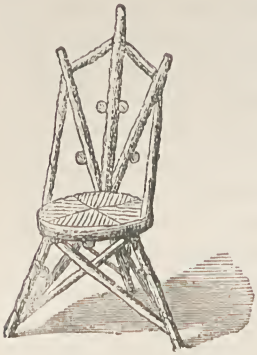


FIG. 526. GARDEN CHAIR.

1009. The table shown in fig. 527 is made by selecting a small tree that has been taken up by the roots, and cutting the roots so as to form the tripod, which takes the place of the claws of the pillar table, and the branches as supports for the top. To make the top, some pieces of rough deal may be clamped together, and covered on the upper surface and round the edge with split sticks or hoops, with the bark on, as suggested above.

Rustic table.

FIG. 527. GARDEN TABLE.

1010. Lastly, as a means of ascent and descent from one level to another, the rustic steps and fences on either side, exhibited in fig. 528, will be found picturesque in the extreme. The trunks of four small trees are let into the ground to form posts at the top and bottom of the stairs, supporting pots or ornamental vases containing plants. These posts are connected by boards placed at the requisite slope to form the sides of the steps, the steps themselves being formed of earth well rammed,

Rustic steps and fences.

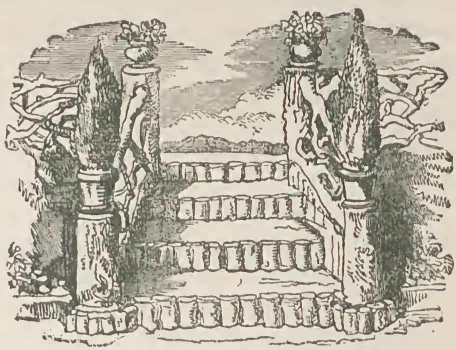
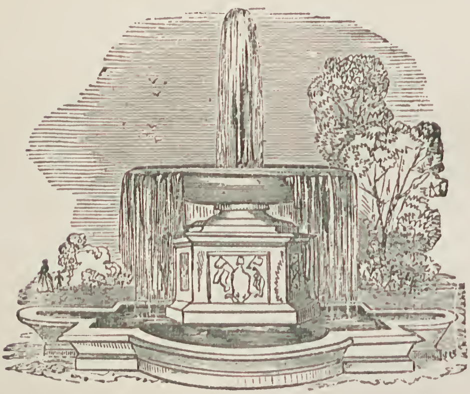


FIG. 528. RUSTIC STEPS.

and held in place in front by boards attached to cleats nailed to the sloping sides. Balusters of gnarled oak are placed between the posts and above the solid part of the sides, and a rustic finish is given to the whole by nailing pieces of fir poles, cut to the requisite length and split in half, to the front of the steps. The sides of the steps are also finished in the same way. It is unnecessary here to enter into minute details of construction, for the amateur who has followed us step by step through these pages, combining actual practice with the theory of the carpenter's art, will find no difficulty whatever in determining these for himself.



CHAPTER XI.

BUILDERS' AND CARPENTERS' IRONMONGERY SUITABLE FOR AMATEURS.

Builders' and Carpenters' Ironmongery—Prices approximate only—Air-bricks, Air-gratings, and Ventilators — Bench Screw — Bolts and Nuts — Bolts for Doors, etc.—Blind-roller Ends, Racks, etc.—Brackets—Casement Fasteners—Castors for Tables, Couches, etc.—Coal Plates—Cresting—Cupboard Turns—Drawer Handles and Rollers—Felt for Roofing—Furnace Doors and Grates—Glass Paper—Glue—Gutters and Rain-water Pipes—Hinges of all kinds—Hoop Iron—Knobs and Buttons—Hall-door Fittings—Latches—Lock Furniture—Locks of all kinds—Nails of all kinds—Sash Fasteners, Lines, Pulleys, etc.—Screws of all sizes — Shutter Furniture—Spikes — Umbrella Brackets — Miscellaneous Articles—Where to buy.

1011. THE various articles comprised under the general term of builders' and carpenters' ironmongery are so numerous that it has been judged more convenient for the purposes of the amateur, instead of giving the prices of different kinds of one and the same article, whenever one or other of the sort has been mentioned in the foregoing pages, to group them together in one place and in one chapter, classifying them under their respective headings, putting, for example, all kinds of hinges under the sub-heading "Hinges," etc., etc. The list has been made as general as possible, keeping in view those articles which the amateur is most likely to require. It must not, however, be supposed that it comprises everything that is contained in the ironmonger's list, for a complete catalogue would occupy more space than we have at our command.

Builders' and carpenters' ironmongery.

1012. The prices given in the following list must be taken as approximate only. In every wholesale ironmonger's list notification is made that the prices quoted are subject to alteration without notice.

Prices approximate only.

1013. AIR BRICKS, AIR GRATINGS, AND VENTILATORS—

			Each.	Per doz.
Air Bricks,	4½in. × 3in.	...	–/3	2/2
,,	9in. × 3in.	...	–/4	3/3
,,	9in. × 6in.	...	–/7½	6/11
Sliding do.	9in. × 3¼in.	...	–/9	8/4
,,	9in. × 6in.	...	1/6	15/6
Air Gratings	4⅜in. × 38in.	...	3/6	40/–
,,	3½in. × 25in.	...	2/10	32/–
Air Gratings	6in. × 24in.	...	3/9	—
,,	6in. × 36in.	...	5/–	—

Ventilators, Round and Square, each—

4in., 1/3	...	5in., 1/5	...	6in., 1/9
7in., 1/10	...	8in., 2/2	...	9in., 2/4
10in., 2/10	...	11in., 3/2	...	12in., 3/8

Ditto, Long (Dr. Arnott's)—

9¾in. × 7¼in. 7/6 each ... 11in. × 8in. 8/6 each
12in. × 9in. 9/6 each ... 15in. × 9in. 11/6 each

1014. BENCH SCREWS, from 2/- to 2/6 each.

1015. BOLTS AND NUTS—

Bright Round Heads, from -/9 per doz.

3in. and shorter, diameter $\frac{3}{8}$in. and $\frac{5}{16}$in. -/9 ; $\frac{1}{4}$in. -/9 per doz.

3$\frac{1}{4}$in. and longer, diameter $\frac{3}{4}$in., $\frac{5}{8}$in., $\frac{1}{2}$in., $\frac{7}{16}$in., $\frac{3}{8}$in., -/5$\frac{1}{2}$ per lb.

Rough, with Square Heads—diameter $\frac{1}{2}$in., from 9in. to 12in. long ; $\frac{5}{8}$in., from 10in. to 24in. long ; $\frac{3}{4}$in., from 10in. to 24in. long, -/5 per lb. for all sizes.

1016. BOLTS FOR DOORS, etc.—

Barrel — length 6in., 5/- ; 7in., 7/6 ; 8in., 9/- ; 9in., 10/6 ; 10in., 12/4 ; 12in., 15/- per doz.

Coach-house Bolts, -/6$\frac{1}{2}$ per lb.

Tower — Solid End — 4in., 2/6 ; 5in., 3/- ; 6in., 3/4 ; 7in., 4/- ; 8in., 4/7 per doz.

Necked Tower—4in., 3/- ; 5in., 3/6 ; 6in., 4/- ; 7in., 4/8 ; 8in., 6/9 per doz.

Spring Iron — 3in., 2/6 ; 3$\frac{1}{2}$in., 3/- ; 4in., 3/6 per doz.

Ditto—Brass Knob — 3in., 3/- ; 3$\frac{1}{2}$in., 4/- ; 4in., 5/- per doz.

Brass Flush, per doz.—

Front-plate $\frac{1}{2}$in.—4in., 4/- ; 5in., 5/- ; 6in., 6/- ; 8in., 8/- ; 10in., 10/- ; 12in., 12/-.

Front-plate $\frac{5}{8}$in., at above sizes, 4/8, 5/10, 7/-, 9/4, 11/8, 14/-.

Front-plate $\frac{3}{4}$in., at above sizes, 5/4, 6/8, 8/-, 10/8, 13/4, 16/-.

1017. BLIND ROLLER ENDS, RACKS, etc.—

1. Blind Roller Ends.

Brass—1$\frac{3}{4}$in., 4/6 ; 2in., 5/6 per dozen pairs.

Ditto, Stamped—3/- per dozen pairs.

Tinned Iron — 2/- per dozen pairs

2. Blind Racks.

Brass—4in., 3/8 ; 4$\frac{1}{2}$in., 4/3 per dozen.

Patent China Knob, 4/- per doz.

Gee's Patent, 3/- per doz.

1018. BRACKETS, each—

Sizes.	Iron.	Galv.	Cast.	Enamelled American.
4in. × 5in. ...	-/3	Add -/4 each on ordinary black.	-/3	-/5
5in. × 6in. ...	-/4		-/3$\frac{1}{2}$	-/7
6in. × 7in. ...	-/6		-/4$\frac{1}{2}$	-/8$\frac{1}{2}$
7in. × 9in. ...	—		-/6	1/-
8in. × 10in....	—		-/7	1/6
10in. × 12in....	—		1/2	1/9

Shelf Brackets, at per lb. ... ... } -/5
Smaller Sizes, Moulded and Tinned ... }

Cornice Pole Do., from -/8 to 4/- per pair.

" " Rings from -/10 to 5/6 per doz.

1019. CASEMENT FASTENERS, each, from -/4 to 5/6 each.

1020. CASTORS FOR TABLES, COUCHES, etc.—

	Plate.	Socket.	Screw.
1in. ...	1/2 ...	1/6 ...	2/-
1$\frac{1}{4}$in. ...	1/6 ...	2/- ...	2/6
1$\frac{3}{8}$in. ...	1/10 ...	2/6 ...	3/-
1$\frac{1}{2}$in. ...	2/- ...	2/10 ...	3/6
1$\frac{5}{8}$in. ...	— ...	— ...	—
1$\frac{3}{4}$in. ...	2/6 ...	— ...	—
2in. ...	3/- ...	— ...	—

1021. COAL PLATES— 12in. in diameter, 1/10 each ; 14in., 2/8 each.

1022. CRESTING—5in. high, from -/6$\frac{1}{2}$ per foot ; 6in. high, from -/8$\frac{1}{2}$ per foot.

1023. CUPBOARD TURNS—1$\frac{1}{4}$in., 3/- ; 1$\frac{3}{8}$in., 3/6 per dozen.

1024. DRAWER HANDLES AND ROLLERS — Brass Handles, on Plates, from -/7 per pair.

Japanned Wrought Do., from 3d. per pair.

Japanned Cast Do.—2$\frac{1}{2}$in., -/3 ; 3in., -/3$\frac{1}{2}$; 3$\frac{1}{2}$in., -/4$\frac{1}{2}$; 4in., -/6 per pair.

Japanned Rollers, $\frac{3}{4}$in., 1/- ; $\frac{7}{8}$in., 1/5 ; 1in., 2/- ; 1$\frac{1}{8}$in., 2/3 ; 1$\frac{1}{4}$in., 3/6 per doz.

1025. FELT FOR ROOFING—

Asphalted, 32in. wide, -/6 and -/8 per yard.

Slaters' or Sarking Felt, -/6 per yard.

1026. FURNACE DOORS AND GRATES COMPLETE—No. 1, 1/- ; No. 2, 1/4 ; No. 3, 1/10.

1027. GLASS-PAPER, ASSORTED — Numbered, Coarse, Medium, Fine, per sheet, -/$\frac{1}{2}$; per quire, -/10.

1028. GLUE, per lb., Town, -/6 ; French, -/7$\frac{1}{2}$; Scotch, -/9.

1029. GUTTERS AND RAIN-WATER PIPES—

1. Gutters.

		3½in.	4in.	4½in.	5in.
Half Round ...	per yd.	–/8½	–/9	–/11	1/1
Angles	each	1/1	1/2	1/3	1/5
Nozzles	,,	1/–	1/2	1/3	1/5
Stop-ends ...	,,	–/3½	–/4	–/4¼	–/4½
O.G. Plain Clip,	per yd.	–/11	1/–	1/2	1/4
Angles	each	1/3	1/4	1/7	1/10
Nozzles	,,	1/3	1/4	1/7	1/10
Stop-ends ...	,,	–/3½	–/4	–/4¼	–/4½

O.G. Lion Clips about –/1 in advance on Plain Clips in every item.

2. Rain-water Pipes.

		2in.	2½in.	3in.	3½in.	4in.	4½in.
Pipes,	per yd.	1/–	1/2	1/4	1/8	1/11	2/8
Heads,	each	1/6	1/9	2/–	2/3	2/6	3/4
Shoes,	,,	–/11	1/1	1/3	1/7	1/11	2/6
Bends,	,,	1/3	1/7	1/9	2/3	2/7	4/–

Off sets, from 3in. projection to 15in. do., from 1/3 to 5/5.

1030. HINGES OF ALL KINDS—

1. Wrought-back flap, 1¼in., –/3; 1⅜in., –/3½; 1½in., –/4½ per pair.

2. Cast Butts, per pair.

	1½	1¾	2	2¼	2½	3	3¼	4
Light ...	–/1½	–/2	–/2½	–/2½	–/3½	–/4	–/5	–/6
Best ...		–/3	–/3	–/3½	–/4	–/8½	1/3	1/8
Cast Skew				–/8	–/9	–/10½	1/–	1/4

3. Brass Hinges for Cabinet Work, per pair.

	1½	1¾	2	2¼	2½	3	3½
Light	–/3	–/4	–/4½	–/5	–/6	–/7½	1/–
Strong	–/4	–/5	–/6	–/7	–/8	–/11	1/6

4. Cross Garnets, or T Hinges, per pair.

Nos.	3.	4.	5.	6.	7.
	–/4	–/6	–/7	–/8	–/9

5. Parliament, for shutters outside.

	4in.	4½in.	5in.	Open.
Cast	–/7½	–/10	–/11	per pair.

1031. HOOP IRON—

For Bonding		13/9 per cwt.
For Tonguing	1 × 20 ...	13/9 per cwt.
,,	⅞ × 20 ...	
,,	¾ × 20 ...	

1032. KNOBS AND BUTTONS—

1. Knobs—Cupboard.

		⅞in.	1in.	1¼in.	1½in.
Brass ...	...each ...	–/1½	–/2	–/2½	–/3½
Japanned ...	per doz. ...	–/5	–/6	–/7½	1/–

2. Buttons.

–/10 per doz., or –/1½ each.

Brass	from	–/1	to	–/8	each.
Japanned	,,	–/½	,,	–/3½	,,

3. Drawer Knobs.

Mahogany, –/2; Japanned Wood, –/1 per doz.

1033. HALL DOOR FITTINGS—

Door Chains, Japanned, 8in., 1/–; 9in., 1/3; 10in., 1/6 each.

Knobs, japanned iron, from –/6, –/7, and –/8; bronzed, from 1/6; China—white, from 1/–; China—black, from 1/3 each.

Knockers—Japanned, from –/8 to 1/10; bronzed, from –/10 to 2/6 each.

1034. LATCHES from 1/– to 15/– each.

Bow Latches—

One Bolt }
Two ,, } from –/9 to 1/9 each.

Night Latches from 1/– to 15/– each.

Bramah Latches, 4 guard, 2 keyed, 5/6 each.
,, ,, 5 ,, 4 keyed, 9/– each.
Lever Night Latches, 2 keyed, from 5/6 each.
6 Lever Night Latches, 2 keyed, from 15/–.

Water Closet Latches—

	3in.	3½in.	4in.
Brass ... ... each ...	3/–	3/6	4/–

Norfolk Latches—Wrought—

Nos.	1.	2.	3.
	–/4	–/5	–/6 each.

Suffolk Latches—Wrought—

Nos.	1.	2.	3.
	–/8	–/10	1/– each.

1035. LOCK FURNITURE—

In China, white and black, plain, gold lines, or ornamented, from –/9 to 4/– per set.

Finger Plates in China to match, from –/10 to 12/– per pair.

1036. LOCKS OF ALL KINDS—

1. Cupboard Locks, from –/3 to 4/– each.

2. Dead Locks.

		4in.	5in.	6in.
Fine Ward	each...	–/10	1/–	1/6
Odd ,, ...	,, ...	1/–	1/4	1/10
Solid ,, ...	,, ...	1/8	2/2	3/3

3. Drawback Locks, each.

	7in.	8in.	9in.
Fine Ward	2/–	3/–	5/6
Odd Ward, Slide behind ...	3/–	5/–	6/6
Solid ,, ...	4/6	5/9	7/6

4. Mortise Locks, English, without Furniture, 2/– each; 5in., thin, for 1½in. doors, complete, 1/6 each.

5. Rim Locks, English from 1/4 to 6/6 each, complete with Furniture.

6. Mortise Locks — American, from 3/– to 16/– each, without Furniture.

7. Rim Locks — American, 5/– each, without Furniture.

1037. NAILS OF ALL KINDS—

1. French Wire, ½in., –/6 ; ¾in., –/5 ; 1in., –/4½ ; 1¼in., –/4 ; 1½in., –/3½ ; 2in., –/3 ; 2½in., –/3 ; 3in., –/3 ; 3½in., –/2½ ; 4in., –/2½ per lb.

2. Cut Clasps, 1in., –/4 ; 1¼in., –/3½ ; 1½in., –/2½ ; 1¾in., –/2½ ; 2in., –/2 ; 2¼in., –/2 ; 2½in., –/2 ; 2¾in., –/2 ; and from 3in. to 6in., –/2 per lb.

3. Cut Floor Brads, 2in., 2¼in., 2½in., etc., –/2 per lb.

4. Cut Lath Nails, –/2½ per lb.

5. Steel Rose Nails, flat points, 1¼in., –/9 ; 1½in., –/8 ; 1¾in., –/7½ ; 2in., –/7 ; 2¼in., –/6 ; 2½in., –/5 ; and from 3in. to 6in., –/4½ per lb.

6. Joiner's Brads, in packets, ⅜in., 1/6 ; ½in., 1/6 ; ⅝in., 1/9 ; ¾in., 2/2 ; 1in., 2/11 ; 1¼in., 3/10 ; 1½in., 4/5 ; 2in., 6/–.

7. Cut Tacks, Tinned and Blue, all sizes, from –/2 to –/6 per 1,000.

1039. SASH FASTENERS, LINES, PULLEYS, etc.—

1. Sash Fasteners from –/3 to 2/– each.

	2¼in.	2¾in.	3in.
Brass—No. 1.	–/3	–/5	—
,, No. 2.	–/6	–/8	—
,, No. 3.			
,, Very Strong	1/–	1/4	1/9
Iron—China Knob	–/5	–/6	—
Brass—China Knob	1/–	1/4	1/10

2. Sash Lines, per dozen yards—

	Nos. 3 to 10.							
Best Flax ...	–/7	–/8	–/9	–/11	1/1	1/3	1/5	1/8
Sup. Twisted	1/1	1/3	1/6	1/8	1/11	2/1	2/4	2/6

Steel Ribbon Sash Line ... No. 1. up to 30lbs., –/2 per foot.

No. 2. up to 75lbs., –/3 per foot.

3. Sash Pulleys.

Diameter.	1½in.	1¾in.	2in.
American Frame	–/9	–/11	1/4
Iron Frame—best	–/10	1/2	1/8
Iron Axle	1/4	1/6	1/10
Brass Axle	5/10	7/–	8/2

1040. SCREWS. — Nettlefold's make—per gross.

Length in inches.	4.	5.	6.	7.	8.	9.	10.
⅜ ½ ...	–/4	–/4½	–/4½	–/5	–/5½		
⅝ ...	–/4	–/4½	–/5	–/5½	–/6	–/6½	
¾ ...	–/5	–/5	–/5½	–/6	–/6½	–/7	–/7
1 ...	–/5½	–/6	–/6½	–/6½	–/7	–/7½	–/7½
1¼ ...				–/8	–/8½	–/8½	–/9
1½ ...					–/9	–/9½	–/10
1¾ ...							–/11
2 ...							1/–
2½ ...							1/4

Length in inches.	12.	14.	16.	18.	20.	22.	24.
¾ ...	–/7	–/8					
1 ...	–/9	–/11					
1¼ ...	–/10½	1/1	1/5				
1½ ...	–/11½	1/3	1/6½	1/10			
1¾ ...	1/1	1/5	1/8	2/–			
2 ...	1/3	1/6½	1/10	2/2	2/6		
3 ...	1/10	2/2	2/8½	3/4	4/–		
3½ ...		2/9	3/4	4/2	4/11		
4 ...		3/9	3/9	4/6	5/1	6/9	7/6
5 ...			6/3	6/3	7/2	9/6	10/6
6 ...			9/3	9/3	9/9	11/6	13/–

1041. SHUTTER FURNITURE—

Bars, from 12in. to 36in., at –/½ per inch.

Bolts, 8in., –/10 ; 9in., 1/– ; 10in., 1/3 ; 12in., 1/6 each.

Knobs 1/– to 3/– per doz.

	1in.	1⅛in.	1¼in.	1⅜in.
Brass	1/6	1/10	2/2	2/10
China, White ...	1/–	1/2	1/3	1/6
,, Black ...	1/2	1/4	1/6	1/8

Latches, brass knobs, from –/5 to –/9 each.

Rings, brass drop, from –/4 to –/9½ each.

Lifts, brass, from –/2½ to –/7 each ; japanned, from –/1 to –/3½ each.

Studs and Plates, –/3 per pair ; brass, from –/6 to 1/3 each ; japanned, from –/3 to –/7 each.

Shoes, rebated, –/2 each.

1042. SPIKES, per pound, –/4 ; fine, –/5½.

1043. UMBRELLA BRACKETS, with iron pan complete, 3/6 each.

1044. MISCELLANEOUS ARTICLES—Hooks of every description for hat rails, clothes rails, etc., from –/6 to 10/– per doz.

Enamelled iron Hat and Coat Hooks, from 2/3 per doz., complete with Screws.

Japanned ditto, from –/7 to 3/6 per doz.

Letter Plates, from 1/– to 15/– each.

Brass Door Chains, from 1/– each.

Iron ditto ditto –/7 each.

Bright Iron Jack Chain, from –/1½ to –/9 per yard.

Brass ditto ditto –/3 to 2/– per yard.

Coil Chain, black, from –/6 per yard.

Coil Chain, galvanized –/8 per yard.

Cornice Pole Brackets, from –/8 to 4/– per pair.

Ditto ditto Rings, from –/10 to 5/6 per doz.

Seat Stands, iron castings, 16½in. high, 3/– to 8/– each.

Table Stands, iron castings, 26¾in. high, from 14/6 each.

1045. Any and all of the above-named articles, with others that the amateur is not so likely to require, and all kinds of tools used in carpentry and joinery, and appliances used in building, can be procured, of good quality and at moderate prices, in large and small quantities of MR. R. MELHUISH, at his *Builders' and Cabinetmakers' Ironmongery and Tool, Saw, and File Warehouse,* 85 *and* 87, *Fetter Lane, Holborn Circus, London, S.E.*

Where to buy.

PART III.

Household Building Art and Practice.

CHAPTER I.

THE VARIOUS DIVISIONS OF THE BUILDING TRADE: AMATEUR'S BUILDING: THE PLANT HE WILL REQUIRE.

Divisions and Subdivisions of Trades—Exemplification of this Division—Division of Building Trade—Trades combined in Building Trade—Classification, etc., of these Trades—The Excavator and his Work—The Bricklayer and Mason—The Pavior, Slater, and Plasterer—The Sawyer, Carpenter, and Joiner—The Ironmonger, a Middle Man—The Smith and Founder—The Zinc-worker and Wire-worker—The Gas-fitter, Plumber, and Bell-hanger—The Painter, Decorator, Writer, and Gilder—The Paper-hanger—Building Trades brought into Five Groups—What the Amateur can do in these Trades—No Robbery for Amateur to do his own Work—Advantages of Self-help—Practical Knowledge, where useful—Arts best suited to Amateurs—Excavating, etc., for Amateurs—Extent to which he may carry Smith's Work—Casting—Zinc and Wire working—Plumbing and Gas-fitting—Bell-hanging—House-painting and Gilding—Paper-hanging and Glazing—Object of what is said in this Book—Amateur's Plant—House or Shed for Plant—Passage by Side of House—Lean-to Roof, etc., over Passage—Structure against Wall or Fence—Place surmounted by Glass—Space below Glass, how to Shut in—Carpenter's Shop—Useful Building Plant for Amateur—Scaffold-boards, their uses—Putlogs and Scaffold-poles—Cask and Buckets—Iron Pulley—Ladder and Barrow—The Barrow: its Parts—The Sides—The Front-board—The Tail-board—Fitting and Nailing Parts together—The Wheel—How to Make a Wheel—The Disc—The Axle and Gudgeons—Ferrules for Axle—Legs of the Wheelbarrow—Useful Sizes for Ladders—Ordinary Ladder—Staves or Spokes—Iron Bar with Nuts—Ladder with Cleats—Bearing for Cleats—Special Description of Building Plant, why Necessary—The Steps—Construction of Steps—Form of the Steps—The Sides of the Steps—Fitting the Parts together—Frame forming Back of Steps—The Hinges—Attachment of Cords to Steps—Trestles always Useful—How to Make Trestles—Trestles that take to Pieces.

Divisions and subdivisions of trades.

1046. WHEN any art or manufacture begins to assume importance, and there is a continually increasing demand for the articles, be they what they may, that are made by those who are engaged in it, it has been invariably found that in due proportion to its growth the art or manufacture, as the case may be, becomes divided and even subdivided into many and various branches, until it is well-nigh impossible to carry the subdivision of the trade to

a greater extent; and in no handicraft, perhaps, has this been carried out to a greater extent than in the manufacture of such little, but useful, articles as watches.

1047. It will be useful, as an exemplification of the manner in which a handicraft trade is divided among many workmen, some of whom are skilled in one branch and some in another, to quote the following remarks on the clock and watch trade from "Beeton's Dictionary of Universal Information" (Science and Art Division), in the article on "Horology." It is there stated that "In England this branch of manufacture is principally confined to London, Coventry, and Prescot. The district of Clerkenwell is the head-quarters of the trade in London. Watch movements are generally made at Prescot and other places in Lancashire; the London workmen make the other parts and put them all together. Thus a Clerkenwell watchmaker buys his movements from Lancashire, and employs tradesmen to finish the making of the watch. These tradesmen are not mere workmen, but small master-tradesmen. The motion-work is supplied by one, the spring by another, the escapement by another; while the case, dial, glass, etc., have each their respective furnisher. The work is again subdivided by these tradesmen in a wonderful manner. Different workmen are specially employed on every kind of escapement, motion-work, hands, dials, etc. An ordinary London watch passes through more than a hundred hands even after the movement has been made in Lancashire."

Exemplification of this division.

1048. Now when we know that in making a watch the preparation of its various parts and its finishing is distributed among so many different workmen, the partition of the great building trade into so many branches, with their subdivisions, will fail to excite surprise, but rather be regarded as an absolute necessity. The building trade, indeed, differs in some measure from that of watchmaking, to which the reader's attention has just been directed; for while the latter is a trade whose various branches have been created by actual division and subdivision, the building trade is rather an aggregation of various trades and their separate departments, which have become affiliated, as it were, and grouped together for the better attainment of the end desired.

Division of building trade.

1049. Taking each a prominent and active part in the building trade we find the excavator, bricklayer, mason, pavior, slater, plasterer, carpenter and joiner, sawyer, ironmonger, smith and founder, zinc-worker, wire-worker, bell-hanger, gas-fitter, plumber, painter, decorator, writer, gilder, paper-

Trades combined in building trade.

hanger, and glazier—a goodly array of tradesmen and artisans whose aid and co-operation is absolutely necessary in building and finishing a house.

1050. Let us endeavour to classify and group these trades, and look into the part that each takes in building work, and having done this let us see to what extent in the work of each the amateur may go, and of what it will be most useful for him to have some slight knowledge; for it must ever be remembered that such knowledge is useful and even essential to a man who occasionally has workmen on his premises, even if he never put his hand to anything of the kind as an amateur, for it will enable him to give a general superintendence to what is going on, and to check in some measure the charges that are made for work done.

Classification etc., of these trades.

1051. The excavator, as his name implies, is engaged primarily in digging—in preparing, by means of pick and spade and barrow, for the foundations of a house, in levelling the spot on which it is to be built, in taking out the trenches for its foundations, and in preparing the approaches that lead to it. He is further employed in mixing concrete for filling up foundations and for making concrete floors, and in making paths, roads, etc.

The excavator and his work.

1052. The bricklayer, mason, pavior, slater, and plasterer work in brick and stone and mortar, and with these various materials. The bricklayer puts up walls and arches and chimneys in brick, a prepared material made ready to his hand in a certain size; the mason, on the other hand, builds with stone of all kinds, and is engaged in cutting and preparing such stonework as may be requisite in a brick house or house of stone, and fitting its various parts into the places they are destined to occupy. The pavior lays stone flooring composed of flat paving stones or materials similar in form, and flooring of bricks and tiles. The slater covers in houses with slates, which are thin plates into which slate or certain kinds of laminated stones can be split with ease, and he is also engaged in forming roofs of tiles of various kinds, made and specially adapted for this purpose. Lastly, the plasterer imparts a smooth coating to the interior walls of houses and their partitions, and covers the exterior, if necessary, with a coating of stucco, cement, plaster, or rough casts—rough or smooth, as the case may be, formed chiefly of lime or cement.

The bricklayer and mason.

The pavior, slater, and plasterer.

1053. The sawyer cuts beams and saws the trunks of trees into planks, either by hand or by machinery; the carpenter frames together the timbers that enter into the construction of a house, and lays

the flooring, etc. ; and the joiner puts up the staircases and all panelling and skirting required, makes and hangs the doors, makes and fixes the window frames and sashes and puts up all the interior fittings of a house that are made of wood.

The sawyer, carpenter, and joiner.

1054. Another group of mechanics work in metal. The ironmonger supplies all the articles, such as hinges, locks, stoves, ranges, sash-fasteners, etc., etc., that are required in a house, with knockers, bells, letter-boxes, door knobs, and other such necessary furniture ; but the ironmonger is a middle man and not an artisan, acting as a medium of intercommunication between those who manufacture these specialities and those who buy and use them. The smith and founder takes an active part in building work, forging bars that may be necessary to insert under the arches of chimney-breasts and other iron-work, to make and see to the fixing of columns, girders, tanks, iron doors, furnace work, boilers, hot-water pipes and their connections, gratings over areas and holes, iron bars for windows, and a variety of articles that will not admit of enumeration. The zinc-worker makes shoots in zinc for the conveyance of water, and covers roofs, generally small in size, with sheets of zinc. The wire-worker bends, cuts, and forms wire into wire gratings, and prepares trellis wire-work, window blinds, etc. The gas-fitter sees to the connection of all pipes conveying gas, and the fixing of gasaliers, etc. ; and the plumber looks to all work into which enters the fitting of leaden pipes for the conveyance of water, and therefore to the fixing of cisterns, water-closets, ball-taps, sinks, etc. The bell-hanger fixes bells, and looks to the mechanical arrangements by which, by means of cranks, springs, and wires, bells are connected with the handles, by pulling which they are set in motion.

The iron-monger, a middle man.

The smith and founder.

The zinc-worker and wire-worker.

The gas-fitter, plumber, and bell-hanger.

1055. Lastly, we come to the painter, who covers wood-work and metal-work with a coating of colouring matter, mixed with oil and turpentine, and generally called paint, in order to preserve the one from decay and the other from corrosion through the action of the weather, and colours walls, ceilings, etc., with oil colours, or more commonly in distemper. Artistic work on walls and ceilings is usually carried out by the decorator, who works out a design with the brush, or quickly imprints a pattern by aid of stencil-plates. The aid of the writer is sought to paint the name of the house or its number on the pillars of the entrance gate

The painter, decorator, writer, and gilder.

or on the front door; and that of the gilder in covering all surfaces that are to be gilt with leaf-gold. The paper-hanger covers the interior surface of walls with paper-hangings, often beautifully and artistically printed in colours; and the glazier fixes panes or sheets of glass into sash-frames, and in skylights, green-houses, conservatories, etc., with putty, after cutting them to the size required.

The paper-hanger.

1056. Thus, in five great divisions of digging and preparing for building work, putting up walls, etc., and covering in with the roof; fitting, framing, and finishing in wood; working in metal of various kinds; and painting and glazing and the general work of decoration, we have placed before us—broadly, it is true, for convenience of consideration, and by no means in minute details—the principal divisions of building work, classified partly according to the materials employed in each, and partly according to the nature of the work that is done.

Building trades brought into five groups.

1057. And what, it may be asked, can the amateur do with regard to these various trades? He may do a little rough carpentry, and he may manage to rub over a door or any other wood-work with some paint, but he can take no part in the other handicrafts that have been named. To this we may rejoin that, although it is not to be supposed that an amateur who has but little time at his disposal for such kind of work can attain proficiency in the practice of any; yet it is certain that there are various simple processes in each branch of the building trade that he can contrive to do creditably, if not in a thoroughly workman-like manner, and by so doing benefit himself by keeping in his pocket money that would otherwise be paid for labour of one kind or another.

What the amateur can do in these trades.

1058. All men must live, and it may be argued that a man by acting as his own mechanic may keep money out of the pocket of some working-man, and bread out of the mouths of the mechanic's wife and family. On reflection, however, it will be seen that unless a man's time be wholly unemployed he can never hope to spend many hours throughout the year in handicraft work, and that any work he may turn his attention and his hand to would be done by a working-man in as many hours as the amateur will take days and perhaps weeks about it. The amusement, in fact, will be a greater gain than the money actually saved, and next to these points is this—that by doing any little piece of repairs for himself the amateur will often save time, inasmuch as he may be able to do a thing directly instead of

No robbery for amateur to do his own work.

Advantages of self help.

waiting for it to be done at the convenience of the workman, and in addition to this much inconvenience and extension of damage, which might result from letting things remain as they were till a workman could be got to attend to them. An old proverb says aptly enough, "A stitch in time will save nine," and no one will appreciate its truth better than the amateur who is capable of helping himself.

1059. It is in doing repairs of an ordinary nature that the amateur will find practical knowledge of the arts connected with the building trades of use to him, in the first place. Secondly, he will find it of equal value in constructing any small building for use or ornament, or for both, out of doors, or for making any appliance within doors; and thirdly, as it has been already urged, he will find it of even more value in enabling him to look after men who may be at work on his premises, and in seeing that the work is done in a proper manner.

Practical knowledge: where useful.

1060. Carpentry and gardening are the arts to which most amateurs naturally turn their attention. The latter does not come in any way within our scope, but it is fair to suppose that most buildings that the amateur artisan will ever carry out will be chiefly in connection with the garden, or in housing animals that he may feel inclined to keep. Of the processes involved in carpentry, and how they may be turned to practical account, mention has been made in the other sections of this work, and there will be no occasion to revert to them. In this part it is our business to consider constructive work or repairs that the amateur may carry out in connection with the house indoors, and the garden and all parts pertaining to it out-of-doors.

Arts best suited to amateurs.

1061. Excavations of all kinds can easily be compassed by the amateur, and he will find no difficulty whatever in making and using concrete. In connection with this kind of work lies the making of garden walls and paths of all kinds, and no one will deny that it is of advantage to the amateur to know how to do these things. In building walls with brick and stone he will probably fail, and more particularly because it is by no means as easily done as other kinds of work that fall more naturally within his compass; but, at the same time, it is desirable to know how to repair and "point" a piece of garden wall, as it is technically called; to fix a step that has become loose with cement; to put a piece of paving to rights and relay a loose paving-stone; and to repair a piece of plastering that has been displaced by damp or other causes.

Excavating, etc., for amateurs.

1062. Similarly he may not be able to accomplish much in smiths'

work, but it is certainly of advantage to be able to work in iron so far as to be able, by aid of fire, hammer, and anvil, to beat a piece of iron into any shape that may be required, to drill a hole, and to turn a screw, which operations come under the category of forging. Casting, which necessitates the melting of metal in a furnace and running it into a mould, is an operation which may well be left to the iron-founder ; but it is useful to possess an iron ladle, and run in lead round an iron bar or rail that has been loosened in the socket cut for it in a stone coping or step. Zinc-working, as far as making a simple shoot and covering a small flat roof are concerned, and wire-working in the construction of a wire trellis, hanging basket, sieve for sifting earth or cinders, or repairing such articles, are far more practicable ; and soldering and simple working in sheet metal are matters with which the amateur may readily make himself acquainted. Plumbing and gas-fitting, which if badly and inefficiently done may involve serious consequences, are best left to professional artisans ; but it is as well to know how to stop a leak in a pipe on an emergency, how to take down a gasalier, clean it, and put it in its place again, and how to substitute new gas-burners for old ones with safety. Bell-hanging is a difficult and tiresome undertaking, and the amateur will find it better to confine his attention to effecting repairs, and not to attempt to put up a new bell, and arrange the cranks, wires, and pulls by which it is moved.

Extent to which he may carry smith's work.

Casting.

Zinc and wire working.

Plumbing and gas-fitting.

Bell-hanging.

1063. In the decorative portions of the building trade he will find no very great difficulty. House-painting—that is to say, covering wood or metal with a uniform surface of oil paint—may be easily managed, and to a person possessed of taste and manual skill the work done by the decorator will present no very great difficulty. Gilding with leaf-gold is an operation that is more tedious than difficult, but much effective work may be done with Bessemer's or Judson's gold paint, in which the amateur will find an excellent and effective substitute for leaf-gold. Paper-hanging requires nothing more than care and a certain amount of manual dexterity. Glazing is more easily done than most of the work that has been mentioned, but as it involves handling putty it is not, perhaps, very desirable work. Still, it is work that should be taken up and carried out by the amateur, as he can put in a pane of glass for about half the price at which a professional glazier will do it if the work be such as can be done at the

House-painting and gilding.

Paper-hanging and glazing.

shop, as the glazing of a light for a pit-frame, etc., and for from one-sixth to one-fourth the price charged if it be a window.

Object of what is said in this book.

1064. It will be understood, therefore, that in the following pages it will be sought to show what an amateur can do in each and every branch of the building trade; and how he must set to work to do it, rather than to furnish anything approaching to a full and complete course of instruction in these, which would be comparatively useless. Although work incidental to each trade may be touched on, in no case will a thorough description be given of any process, be it what it may, that the amateur would find it too difficult or impossible to carry out.

Amateur's plant.

1065. Every amateur who makes up his mind to go in systematically for work of this kind should take care to be possessed of the "plant" necessary for carrying it out. The tools that are absolutely necessary for the performance of each kind of work will be specially described in the chapter and section devoted to its consideration; but there are a few things that may be mentioned here as being generally necessary for all kinds of work more or less, and with which the amateur should provide himself.

House or shed for plant.

Passage by side of house.

1066. If the amateur is not possessed of an outbuilding suitable for housing his plant, one should be constructed in some out-of-the-way corner of the premises. A coach-house, if it be not used for its legitimate purpose, affords a capital place wherein to stow things of this kind; and even if it be, a portion of it may be easily devoted to this purpose. Sometimes there is a long, narrow passage on one side of a house, detached or semi-detached, which, not being used as a general thoroughfare by any but persons living in the house, may be roofed over at trifling expense, and used as a shed in part: for most of the plant used by the amateur, such as ladders, poles, boards, etc., will admit of stowage against either house-wall or garden-wall—that is to say, the wall opposite the house-wall on which the lean-to roof rests, and which forms the line of division between the premises occupied by the amateur and the premises adjoining. This idea is represented in fig. 529, in which, by means of a narrow row of glazed lights of no great height on the low brick partition wall C, and

Lean-to roof, etc., over passage.

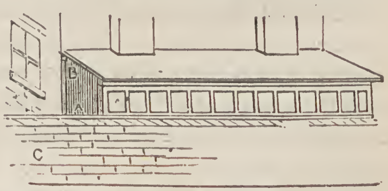


FIG. 529. PASSAGE BY SIDE OF HOUSE FOR PLANT, ETC.

a narrow lean-to roof, B—which may be of glass, or of wood painted or covered with zinc or roofing-felt, as the amateur may feel disposed—a place of shelter may be easily constructed at little cost, in which many useful things may be housed and kept out of sight; and if the amateur is not able to manage in this way, a convenient hiding-place may be made against a cold north wall, and in such a way as to add to rather than diminish the beauty of the garden. In the design given in fig. 529, it should be said that a light shoot or gutter should extend along the eaves of the roof from one end to the other to catch the rain that may fall on it, and this may be led by a pipe from the shoot into a drain; or, if it be an object to preserve it for the garden, into a small cask placed behind the wall at C, or a tank sunk below the surface of the ground, and therefore hidden out of sight, whence the water may be raised when required by a small pumping apparatus.

Structure against wall or fence.

1067. To return, however, to the structure against a north wall or fence. This may be managed as shown in fig. 530. Supposing there to be a wall running along the north end of the garden, or the end having a north aspect, a platform may be constructed about half-way up the wall, as at C. Below this platform will be a convenient place for placing ladders, barrows, etc., and everything of this kind; and above it may be erected a glass structure, partly carried up to the top of the wall and partly above it, with the shorter front lights opening outwards, and the longer ones arranged as sashes to slide to and fro. The low compartments are admirably adapted for auriculas, while the higher and central space will be found useful for wintering larger half-hardy plants. The lower space may be shut in, if desired, by a series of doors, hinged on the bottom part of a frame, buttoned at the top and opening outwards, or it may be left open. If it be left open, it will be desirable to have some evergreens in a narrow border on the other side of the gravel path in front of it, or a raised bank, in order to mask the view entirely or in part.

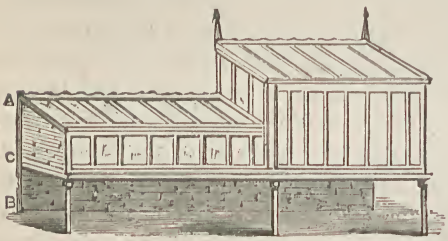


Fig. 530. STRUCTURE AGAINST WALL FOR PLANT, ETC.

Place surmounted by glass.

Space below glass: how to shut in.

1068. A separate shelter of some kind should be provided for any building apparatus that the amateur may possess, or intend to possess.

It must not be stowed away in his carpenter's shop, if he have one, for it will be in the way, and by hindering him in his carpentry and joinery will prove a nuisance. "A place for everything, and everything in its place" should be carried practically into effect by the amateur with regard to all his tools and appliances, for every kind of work that he may undertake.

Carpenter's shop.

1069. With regard to "building plant," strictly so called, it is desirable for the amateur to possess a ladder or two, one shorter and the other longer, a barrow, a set of steps, a couple of trestles, three or four scaffold-boards, some cords, and perhaps half a dozen scaffold-poles, and putlogs or cross-timbers, one end of which is inserted in the wall as it is being raised by the builders, and the other end lashed fast to a scaffold-pole by a piece of rope. A half cask, two or three buckets of galvanised iron, and a broad piece of wood, consisting of three or four short boards nailed on to ledges, will also be found useful, and an iron pulley or two.

Useful building plant for amateur.

1070. The scaffold-boards may be purchased at the timber-yard. They should be 11in. wide and not less than 1¼in. in thickness, and should have hoop-iron nailed round each end to keep them from splitting. Besides forming a platform when supported on trestles or putlogs, these boards are handy in forming a sort of tram-road on soft earth or a rotten path for wheeling soil, gravel, manure, etc., from one part of the garden to another. Pieces of stout quartering will serve as putlogs, and may be bought ready sawn. Scaffold-poles—under 20ft. in length will be tall enough for the amateur—can also be bought at the timber-yard, and all ropes sufficiently good and strong enough for his purpose may be procured from the marine store-dealer. The prices of these articles may be estimated as follows :—

Scaffold-boards: their uses.

Putlogs and scaffold-poles.

	s.	d.		s.	d.
Scaffold-boards, per foot run, 2d. to	0	3	Putlogs, per foot run	0	1
Scaffold-poles, 18ft. or 20ft. long, each...	2	6	Old ropes, say per fathom..................	0	6

The half cask may be bought at the marine store shop, of the second-hand dealer or the cooper, and will cost from 1s. 6d. to 3s. 6d., according to size and quality. If it is necessary to furnish it with new hoops the smith or cooper will do this, charging from 6d. to 1s. per hoop, according to size. Galvanised iron buckets cost from 1s. to 2s. 6d., according to size. The broad piece of wood, useful for mixing mortar or cement on, can be made by the amateur out of some spare boards. An iron pulley, such as that which is represented in fig. 531, with a grooved edge and a shank cut with a

Cask and buckets.

screw thread, so as to screw into a cross-beam or putlog, may often

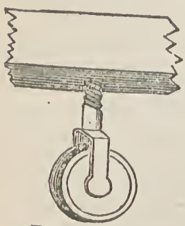


FIG. 531. IRON PULLEY.

be picked up at prices ranging from 6d. to 1s. at a marine store-dealer's, or in less elegant language, a rag-and-bone shop. When new they will cost twice that amount, if not more. Iron pulley.

1071. If the amateur is not provided with a ladder, a barrow, a set of steps, and some trestles, he may make these for himself very easily. The barrow will prove the most difficult job, but it is to be made, nevertheless, as we will show presently. Of late years a convenient iron barrow has been introduced, consisting of a receptacle of sheet iron, resembling a broad, shallow box, supported on an iron frame-work furnished with handles and a wheel. They have the merit of being strong, light, and easy to wheel along, even on comparatively heavy ground. Ladder and barrow.

1072. Let us proceed, first of all, to describe the barrow, which should be made of elm, as this kind of wood will resist the destructive effects of moisture better than any other, and, indeed, will last for many years under water. If the amateur is not inclined to work wood so tough and hard as elm, he must content himself with good sound deal. The parts which compose the barrow may be enumerated as the two sides, the front, the tail board, the bottom, the wheel, and the legs. The shape of the sides is shown in fig. 532. No dimensions are given, as the size of the barrow must The barrow: its parts.

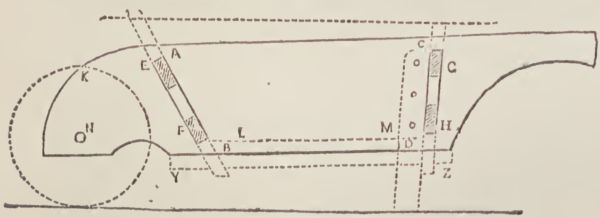


FIG. 532. WHEELBARROW—SIDE ELEVATION.

be suited to the power of the person who will mostly use it ; and the best thing the amateur can do is to take the dimensions of a barrow that suits him, and from the figures given make a working drawing to scale. The sides are precisely alike, and the solid line in fig. 532 shows the exact shape, the line at the bottom being parallel to that at the top. A shallow groove must be made in the *inside* surface of each side, as at A B, C D, and in these grooves The sides.

mortise holes must be cut, as at E and F in A B, and G and H in C D. It will be noticed that the slant given to the groove A B is greater than that given to C D. The reason is that by doing so the front board is kept out of the way of the wheel, whose position is indicated by the dotted circle K, and that any material with which the barrow is loaded can be turned out all the easier when the barrow is canted over. Fig.

The front board. 533 represents the front board: the projecting parts at A and A rest on the top of each side, and the mortises on each side, lettered E and F, fit into the tenons so lettered in fig. 532. The tail board

The tail board. is made in the same manner, but it need not be higher than the dotted line *a b* in fig. 533. A mortise, X,

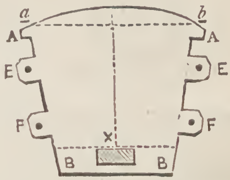


FIG. 533. WHEELBARROW—FRONT BOARD.

should be cut in both front board and tail board, the upper part of the mortise hole being just on a level with the bottom line of the sides. These holes serve to sustain a stout slip of wood, which in its turn helps to give strength to the bottom and hold it up. Its position is shown by the dotted line Y Z in fig. 532. When the front board and tail board have been put in their places, and the parts brought tightly together by a few blows of a mallet, lines should be drawn with a pencil, or scribed with a bradawl or any sharp-pointed instrument, to

Fitting and nailing parts together. show just where the outside surface of each side comes. The parts must then be knocked apart and holes bored through the tenons with a large gimlet, rather outside than inside these scribe-marks. The sides and front board and tail board must be once more put together, and stout iron pins, or, if the tenons and the holes in them be large enough to admit of it, strong wooden pins of oak or ash driven through the holes bored in the tenons. The bar which is to assist in sustaining the bottom is then to be driven through the mortise holes made in the front board and tail board, and the bottom, made of *one piece of elm* if possible, cut so as to fit accurately and tightly into the space at the bottom of the framing formed by the front, back, and sides, and rest on the bar below, to which it may be secured by nails or three or four 2in. screws. The sides, front and tail boards, should then be nailed to the bottom with 2in. clasp nails.

1073. The wheel should be put in place before the pins are driven

The wheel. through the tenons of the front and back pieces, so that the projecting irons at each end of the axle may be thrust through the hole N made in each side to receive them. It will be bet-

ter for the amateur to buy a second-hand wheel of the marine-store dealer, which he can generally do for 1s. or 2s., and then make the frame of his barrow to suit the wheel. If, however, he has to make one he must proceed in the following manner :—

How to make a wheel.

1074. Cut out a circular piece of board 12in. in diameter, and exactly in the centre cut a square mortise, as shown at A in fig. 534. The wood for the wheel should not be less than 1in. in thickness, and elm is as good as any that can be got for the purpose. If the amateur cannot get a piece of elm, he must make his wheel 11in. in diameter and use ¾in. stuff, cutting out two circles and screwing them tightly together so that the grain of one piece may run in an opposite direction to the grain of the other. A piece of hoop iron should be bound round the circumference in either case, fastened with nails, in the centre if the wheel be solid, but alternately, first near to one edge and then to the other, if it be composed of two pieces. A square piece of deal—or better, oak or ash—should be cut to key into the square hole in fig. 534. This forms the axle, as shown in fig. 535 at B C.

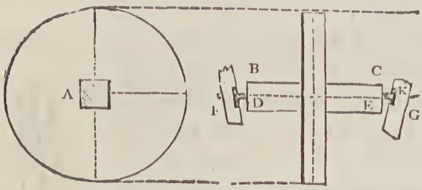


FIG. 534. SIDE ELEVATION. FIG. 535. FRONT ELEVATION.
WHEEL OF WHEELBARROW.

The disc.

FIG. 536.
GUDGEON.

FIG. 537.
FERRULE FOR AXLE.

The axle and gudgeons.

Precisely in the centre of each end of the axle should be driven an iron spill or piece of iron, called a gudgeon, square at the end that is driven into the wood and round at the other. These should project just far enough beyond the ends of the axle to go through the sides and extend from ¼in. to ⅜in. beyond their outer surface. These gudgeons are shown at D and E, and the manner in which they should project beyond the sides at F and G. A small iron plate about ¼in. thick should be let into the side of the barrow on the inside surface to receive the gudgeons, as shown at H and K in section, and larger in fig. 536 in plan. These prevent the wearing away of the wood which would otherwise be caused by the friction of the gudgeons. The smith will supply the plates ready for use for about 6d. per pair. It will be noticed that as the sides of the barrow approach closer together at the bottom than at the top and are slanting, the holes through which the gudgeons pass must be bored in a slightly slanting direction.

This is apparent from the sections of the sides shown at F and G in fig. 535. If it is thought desirable to do so, the axle can be tapered and rounded on either side, as shown in fig. 537, and ferrules, as at A, fitted over each end before the gudgeons are inserted. The ferrules may be obtained at the smith's, 1¼in. in diameter inside, at from 6d. to 8d. per pair, and gudgeons at about 3d. or 4d. per pair. The ferrules should be brought to a red heat in the fire before they are put on the ends of the axle. As soon as they are on they should be plunged into cold water, which makes the iron contract and fit closely to the wood.

Ferrules for axle.

1075. To finish the wheelbarrow the legs must be added. These must be cut so as to be of the shape in section represented by A B in fig. 538; by cutting them in this manner they can be fitted closely to the slanting sides, as at C D, and yet be upright as far as the outer surface is concerned. They should be screwed on to the sides with 2in. or 2½in. screws, according to the thickness of the legs, just in front of the tenons of the tailpiece, against which they may be abutted, or set perfectly upright, if the maker of the barrow consider this to be preferable to the other mode.

Legs of the wheelbarrow.

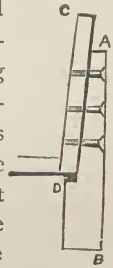
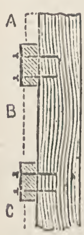


FIG. 538. LEG OF WHEELBARROW.

1076. We have now to deal with the ladder and steps. It will be as well for the amateur to have two ladders, one from 10ft. to 12 ft. in height, the other from 15ft. to 18ft. long. These will be long enough for all purposes for which he will require them. The longer ladder, if 18ft. long, will be long enough to get at a first-floor window comfortably if it be necessary, and this is all the amateur can possibly require. For repairing roofs, etc., ladders of great length are used; but this is dangerous work, and had better be left to those that are accustomed to it.

Useful sizes for ladders.



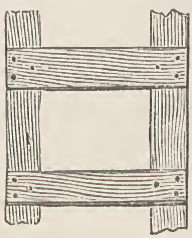


FIG. 542. SIDE VIEW. FIG. 541. FRONT VIEW.
LADDER FORMED OF CLEATS.

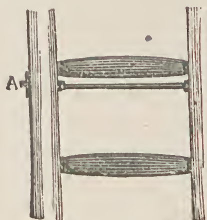


FIG. 539. FRONT VIEW. FIG. 540. SIDE VIEW.
ORDINARY LADDER.

1077. There is no difficulty in making a ladder. There are two methods, both of which are shown in the annexed figures. The ordi-

nary way is shown in fig. 539. A fir pole of the requisite length is taken and planed nicely all round. It is then marked along its length in divisions of about 9 inches, the first mark being 9 inches from the end, and the last the same distance from the top, and holes are then bored right through the pole with a ¾in. or ⅞in. bit. The pole is then sawn in half from end to end, and some spokes of oak or ash, generally called staves or rounds, thickest in the middle and tapering towards the ends, are driven into the holes in one half of the pole, the flat side being inwards. The staves are a little longer at the bottom than at the top, so that the ladder may be narrower at the top than at the bottom by an inch, or more if the ladder be a long one. Sometimes an iron bar, as at A, with a shoulder at each end to butt against each side, is inserted instead of a wooden stave, or frequently just below it, and secured with nuts on the outside; one of these is put two or three rounds from the top, and another two or three rounds from the bottom of a long ladder. The other half of the pole is then put on to the other ends of the staves and knocked into place. The ends of the staves are sawn close to the pole, if any project beyond the outside surface, and a cut with a chisel is made across each, and a wedge of hard wood driven in. This is shown in fig. 540.

Ordinary ladder.

Staves or spokes.

Iron bar with nuts.

1078. Another way of making a ladder is to take two pieces of good red deal about 2½in. or 3in. thick and 2in. wide and nail cleats across, as shown in fig. 541, the cleats being 2in. wide and 1in. thick. They should be nailed on firmly with clasp nails. Some notch the uprights slightly and drop the cleats into the notches, but this tends to weaken the ladder. It is far better to secure a bearing for the cleats by nailing strips of wood to the uprights between the cleats, as shown at A, B, and C in dotted lines in fig. 542. This, however, tends to render the ladder somewhat cumbersome, and certainly heavier. The method just described is rather a clumsy way of making a ladder, and should only be adopted for ladders of 12ft. in length and under; for if the uprights be longer they are apt to give under the weight of the person who is upon them, and will sometimes snap asunder, especially when the uprights have been notched to receive the cleats.

Ladder with cleats.

Bearing for cleats.

1079. It may possibly be thought that what is now being brought under the reader's notice belongs rather to Household Carpentry and Joinery than to Household Building Art and Practice. It does so, in so far as some knowledge of carpentry is necessary, but it must be remembered that all sections of the building trade are closely con-

nected, and scarcely any of them can be completely carried out without some assistance from one or other of the rest. It must be further considered that hints and suggestions given in one branch of the whole subject will be found useful in another, and that by dwelling for a short time here on builders' plant that may be made and how to make it, we are only going as it were from the main road into a by-way that loops into it again at no great distance, affording a short and easy cut that many will find it of service to traverse.

Special description of building plant: why necessary.

1080. After this brief explanation of our reason for going off at a tangent for a little time whenever our purpose demands it, we can return to the steps, and show how they are to be made. They will be found useful indoors and out-of-doors alike.

The steps.

1081. The method of making a set of steps will be apparent from the accompanying diagrams. Fig. 543 shows the elevation of a set of steps when extended and viewed from the side; fig. 544 the front elevation, and fig. 545 the back elevation. Fig. 546 is the shape of each step, but it will be noticed that each will be less in length than that which is immediately below it, as for the sake of stability the steps are made wider at the bottom than at the top, as is apparent from the front and back elevations. Two pieces of wood, 5in. in width and 1in. thick, and of a length according to the requirements of the amateur, but not more than 6ft., as the general length or height of steps of this description ranges from 2ft. 6in. to 6ft., must be first selected, and cut on a bevel at top and bottom, as shown by A B C D in fig. 543. Grooves 1in. wide, to receive the ends of the steps, must then be cut, from 6in. to 9in. being allowed from the bottom of the piece to the under side of the lowest step, and 9in. clear between the steps—that is to say, from the upper surface of each to the under surface of the one above it. From ¼in. to ⅜in. is deep enough for the grooves. The upper ends of the sides should be mortised into the top step K, which must be wide enough to project over

Construction of steps.

Form of the steps.

The sides of the steps.

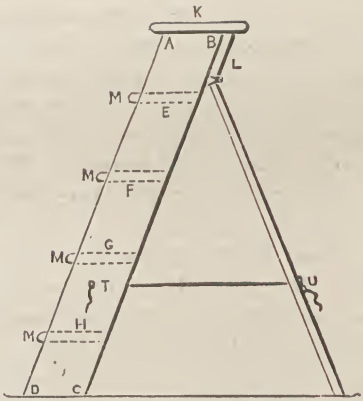


FIG. 543. SIDE ELEVATION OF STEPS.

the piece L that is nailed, or screwed to the sides at the back directly under K, as shown in figs. 543 and 545. As soon as the sides, the top, and the steps are all ready, the front part may be fitted together and secured with nails. The steps must be cut as shown in fig. 546. The sides will enter the grooves cut to receive them as far as the inner dotted lines O P, O P. If it be thought necessary, tenons may be cut on each side of the steps as at N, N, and N, N, to fit into corresponding mortises cut in the sides in addition to the grooves; but this is not absolutely necessary; the top step K, however, must be mortised to the sides. The front of each step laps slightly over the sides, as shown at M, M in figs. 543, 544, and 546.

Fitting the parts together.

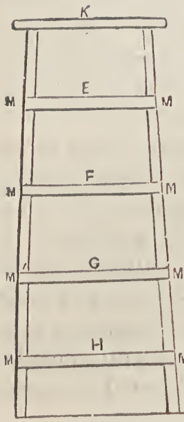


FIG. 544. FRONT ELEVATION OF STEPS.

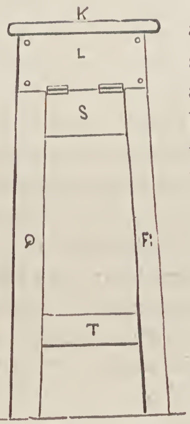


FIG. 545. BACK ELEVATION OF STEPS.

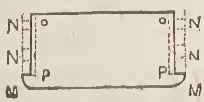


FIG. 546. SHAPE OF STEPS.

1082. As soon as the front has been put together and properly fastened, the piece L must be put on, and a frame made consisting of two upright pieces Q, R, and two rails S, T, as shown in fig. 545. The wood of which this frame is made should be 1in. in thickness, but the length of the pieces Q and R, and of the rails S, T, will depend on the height of the steps and the width of L. From 2in. to 2½in. will be sufficient for the width of the pieces Q, R, and the rail T, but the rail S should be 3in. or 4in. in width. This frame when made must be attached to L by a pair of hinges. A pair of 1½in. or 2in. butts will be found suitable, or what are termed back flap-hinges may be used, but these must be laid on the outside of the piece L, and the rail S, and screwed on to them as shown in fig. 547. The prices of butts and back flap-hinges of all sizes, and various kinds of builders' ironmongery most wanted by the amateur in his work, have been given in Chap. xi. of Part II. of this work.

Frame forming back of steps.

The hinges.

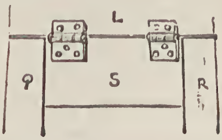


FIG. 547. FLAP-HINGE.

Attachment of cords to steps.

1083. Lastly, means must be taken to prevent the frame at the back from extending too far from the front part of the steps when opened out. This is accomplished by boring holes in the sides of the front and the side pieces of the frame, as at T and U in fig. 543, and passing a piece of stout cord through them, making a knot at each end to prevent its withdrawal.

Trestles always useful.

1084. When engaged in painting or in putting up a shed in the garden, it will be found inconvenient to be constantly moving steps or ladder from point to point. Supports for a temporary scaffolding will therefore be required, and these the trestles will supply. The trestles, indeed, are likely to be all that the amateur will want by way of making scaffolding, but it will be as well, especially if he be at a distance from a town or wood merchant's yard, to keep a few short scaffold-poles and putlogs in stock as suggested.

How to make trestles.

1085. A good general idea of the trestle suitable for the amateur may be gained from an inspection of fig. 548. It is made on precisely the same principle as the sawing stool or mortising trestles used in carpentry. A piece of wood about 2ft. 8in. long, or even 3ft., and about 4in. square, must be selected for the top ; and four legs—B, C, D, E—about 8ft. or 9ft. long, and about 4in. deep by 3in. wide, cut at the top so as to receive and hold the piece A. When these have been placed in position and nailed to A, braces or cross pieces —as shown at F, G, H, K, and L, M, N, O—must be nailed to the legs. A pair of trestles of exactly the same size must be made, and it will be obvious to the reader that when a pair of scaffold-boards are placed on the cross pieces G, K, or M, O, or on the piece A at the top, scaffolding at various heights may be made in a few minutes to suit the convenience of the amateur.

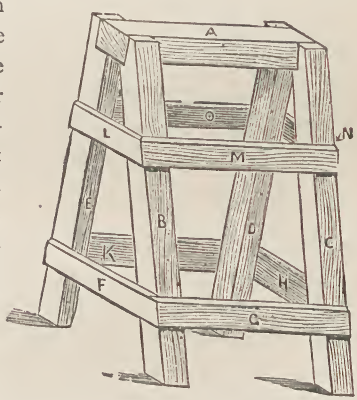
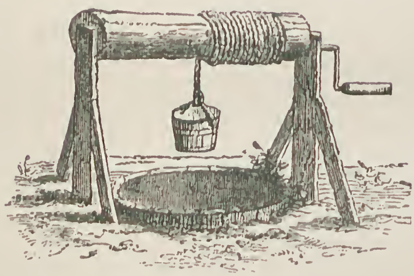


FIG. 548. TRESTLE FOR AMATEUR.

Trestles that take to pieces.

1086. As it may be convenient for the sake of stowing the trestles away to make them so that they may be taken to pieces, it is obvious that it is practicable to make each side of the trestles separately, framing the legs B, E, or C, D together, by cross rails tenoned into them instead of the cross pieces L, F, or H, N,

a third piece being added to connect them at the top and serve as an additional support to the piece A, which will slip into the rectangular opening thus made as into a deep notch. In this case, however, A should be deeper and narrower, so that a bolt may be passed through the framing and A to keep them well together when in use. The pieces G, M, and K, O may be movable, and attached to the framing on either side by bolts passing through the legs, and secured with thumb-screws. These pieces may be wider to admit of two bolts being passed through each end for additional security. When made in this way additional holes may be made in the legs B, E, and C, D, so that the cross pieces G, K, and M, O may be shifted higher or lower as may be necessary.



CHAPTER II.

EXCAVATING, AND WHAT IT IMPLIES: TOOLS: CONCRETE, ETC.

Meaning of term "Excavating"—Wages Paid to Excavator—Jobbing Gardener—Facts Respecting Excavator's Work—Work in Various Materials—Contents of Barrow, etc.—Cubic Yard of Earth—Slope of Embankment—Amateur's Work in Excavating—Scaffold-boards as Tram-road—Spades and Shovels—The Pick—The Crowbar—The Rammer—Levelling Ground—Practical Example of Levelling—How to Hold Earth in Place—The A Level, etc.—Trenches for Foundations—Mode of Procedure—Trenches for Concrete, etc.—Trenching in Loose Earth—Supporting Sides with Boards—Description of Method Employed—Ballast: how to make it—Draining Wet Soil—Materials and Implements—Preparation of Trench for Draining—Different Tools for Trenching—Laying out Drains in Ground—Main Drain—Lateral Drain—Drain-pipes—Connection of Pipes by Collars, etc.—Remarks on Draining—Stiff Subsoil—Porous Ground—Filling in Trenches—Practical Example in Draining—Laying Circular Drain-pipe—Semicircular Tile on Flat Stone—Tiles Required to Drain Acre of Land—Hedges and Embankments—How to Make a Hedge or Bank—Plants in Centre of Bank—Foundation for Quickset Hedge—Use of Stones and Stakes—Staked Hedge must be Turfed—Ornamentation of Stone Foundation—Concrete: what it is—Materials for Making Concrete—Various Cements in Use—Hydraulic Cements—Roman Cement—Portland Cement—Strong and Weak Cement—Stucco for Walls—Prices of Cements—Concrete Should be Made on Boards—"Concrete: its Use in Building"—How to Make Concrete—Precautions to be Observed: (1) Where Water is to be Added. (2) When it should be Added. (3) The Amount to be Added. (4) Turning Over the Concrete—Assistance Necessary when Mixing Large Quantities—Mixing Small Quantities—Filling Trench with Concrete—Why Thrown in from Higher Level—Garden Walks, Paths, etc.—Marking out Course—Mode of Making Path—Construction of Garden Walk—Solid Facing to Path—Asphalte Pavement—Tar Pavement—Concrete Pavement—Finishing Coat—Cost of Garden Walks per Square Yard—Well Sinking—Patent Tube Well—Prices of Tube Wells—Appearance of Tube Well—Mode of Sinking Tube—Improvised Driving Machine—Completion of Remarks on Excavating.

1087. THE term "excavating" is applied primarily to all work done in digging out and removing earth, for whatever purpose this may be done. Thus it is applied to the work done in levelling a place for the site of a house or any building, in digging out the trenches required for foundations or for making drains, in taking out the pits, if we may call them so, that are necessary for cellarage and in sinking wells. It also implies mixing and filling

Meaning of term "excavating."

in concrete, and burning clay into ballast; and although making concrete walls can scarcely be brought under "excavating," yet it is frequently entrusted to labourers employed in this kind of work. Making banks and hedges, and planting them with quickset or other shrubby trees such as hornbeam, etc., comes within the province of the excavator, as well as the making of embankments, slopes, etc.

Wages paid to excavator.

Jobbing gardener.

1088. With regard to wages charged for the excavator, the builder will ask 8d. per hour for his services, or even more when the labourer is working in water; but the amateur, if living in a town, may, if he does not care to do the work himself, get hold of a jobbing gardener, whose charge will be about 4s. per day, or say from 3s. 6d. to 4s. 6d., while if he be located in the country he may without doubt get a man at from 2s. 6d. to 3s. 6d. per day who will work under his directions.

Facts respecting excavator's work.

Work in various materials.

Contents of barrow, etc.

Cubic yard of earth.

1089. The following facts with regard to excavators' work, taken from "Laxton's Builders' Price Book," may be of use to the amateur:—"In loose ground a man can throw up about 10 cubic yards per day, but in hard or gravelly soils 5 yards will be a fair day's work. Three men will remove 30 yards of earth a distance of 20 yards in a day. A yard (cubic) of concrete requires about 3 hours' labour to mix and throw in, or if in heavy masses, and the materials handy, about 2 hours. With regard to the weight of materials, 19 cubic feet of sand, 18 ditto clay, 24 ditto earth, 15½ ditto chalk, 20 ditto gravel, will each weigh one ton. A cubic yard of earth before digging will occupy about 1½ cubic yards when dug. Sand and gravel does not increase more than one-third as much as earth in bulk when dug, but will decrease in height one-fourth more than earth. A wheelbarrow (that is to say the broad, shallow barrow used by navvies) holds $\frac{1}{10}$ yard cube. A cubic yard, or 27 cubic feet of earth, is a single load, and contains 20 bushels; 1 cubic yard of gravel contains 18 bushels in the pit; when dug it will increase nearly one-third in bulk, but will subside nearly one-fourth in height, and decrease one-fifth in bulk when formed into embankments. When earth is well drained it will stand in embankment about 1½ to 1." That is to say, if the height B C of the embankment be 1 foot, or 1 yard, or 12 yards, as the case may be, the length of the slope A C may be 1½ feet, 1½ yards, or 18 yards respectively. Or, what is the same thing, the slope A C should

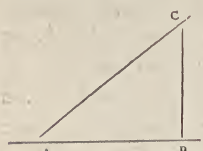


Fig. 549.

form an angle of 40° or 41° with the horizontal base line A B. This will prove a useful rule for the amateur in throwing up embankments, mounds, etc., in his grounds or garden. If revetted, to use an engineer's term, or covered over with turf, the inclination may be greater, because the roots of the grass bind the surface earth together and keep it from being washed down by heavy rains. This will be evident from an inspection of the side of a hedge or bank covered with turf which may be inclined to the horizontal base line at angles ranging from 10° to 20°.

Slope of embankment.

1090. The amateur's work as an excavator will be confined to levelling ground, digging trenches for foundations, sinking pits, perhaps, once in a way. He will also possibly have occasion to make trenches for draining ground, and will sometimes throw up an embankment or make a hedge. He should also know how to mix and fill in concrete for foundations, and above all other matters, how to make garden walks. We will say a few words on each of these points seriatim.

Amateur's work in excavating.

1091. In all work of this kind, when earth has to be wheeled from one place to another, the amateur will find his scaffold-boards very handy as a temporary tramroad for his barrow to run over. He will also require a spade or a shovel for filling his barrow ; a pick for loosening the earth ; a crowbar or iron bar for sinking holes in earth, or for splitting asunder hard, close rubbly stone, or any other similar material that he may encounter ; and an earth rammer for ramming earth into a hard, solid mass.

Scaffold-boards as tramroad.

1092. Everybody knows what a spade is, or it is presumed that everybody does. It is a broad blade of plate iron, square in form but rather narrower at the bottom than at the top, attached by two long straps of iron springing from upper and underside to a handle of tough ash, which is shaped something like a heart, and pierced for the admission of the fingers. Illustrations of spades used in draining will be found further on, and will serve to show approximately the form of the common spade. A good spade costs about 3s. 6d. The spade is a short implement, and although excellent for digging and turning over ground, it is by no means as handy for loading a barrow with earth, or throwing earth from one spot to another, or from a higher to a lower position, or *vice versâ*, as the shovel, which is not so familiar an object as the spade, being more used in the western counties than in and near London. Fig. 550 shows the tools that are chiefly required in excavating. The two shapes ordinarily given to the shovel are shown at A and B. The broad flat blade,

Spades and shovels.

square or pointed as may be preferred, has a socket attached to it, into which is thrust a long, slightly bent handle. The length of the handle enables it to be used as a lever in lifting earth, and throwing it into a cart or barrow. The handle is grasped at the top, or near the top, by the right hand, and at about one-third its length from the socket by the left hand. The blade is thrust into the mass of earth, the left hand pressed against the knee as a fulcrum, and the earth, which in this case is the weight to be moved, is raised by a downward pressure of the right hand coming into play as the power. This cannot be done so well with the spade, owing to the shortness of the handle. The price of a spade is about 2s. without, and 2s. 6d. with a handle.

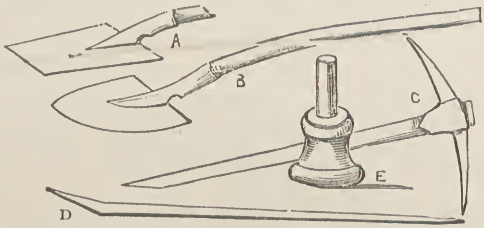


FIG. 550. SHOVEL, PICK, CROWBAR, AND RAMMER.

1093. The pick is shown at C. The blade should be of the best wrought-iron, tipped with steel; the handle of ash. When the point that is downward is driven into the mass that it is desired to loosen, the handle is moved in an upward direction; and the back of the blade pressing against the earth behind it as a fulcrum, the weight in front of the point is detached and loosened. This implement is a good example of a bent lever. Picks are usually sold by the hundredweight, but it is possible to pick up one at the marine-storedealer's for from 1s. to 2s. The points will be worn out, but any smith will tip them anew with steel for about 1s. The crowbar, shown at D, is a long iron bar about ¾in. or 1in. in diameter, pointed at one end, and beaten into a broad point and slightly bent at the other. They are sold by weight for about 3d. per pound, but an old one may be bought, like the pick, of the marine-storedealer for 1s. The earth rammer may be got at the same place. It is a heavy mass of iron, shaped as shown at E, with a hole through it into which an ashen pole, about 6ft. long and 1¼in. or 1½in. in diameter, is inserted. When new it is sold by weight, but when purchased second-hand it may be bought for 1s. or 1s. 6d. It is one of the most useful aids to work that the amateur can have, for it is constantly in request when posts or wooden uprights of any kind are let into the ground in order to ram tightly together stones, brickbats, earth, gravel, etc., thrown in to fill up

The pick.

The crowbar.

The rammer.

the cavity, so that it is impossible to move post or upright in any direction whatever.

1094. The first operation that we may consider is levelling ground, and for the sake of illustration we will imagine that it is desired to make a level platform on slightly rising ground. This is practically the same as levelling a site for a house.

Levelling ground.

1095. Suppose that A B in fig. 551 represents the contour of the ground in section, and that C D is the level of the platform that it is

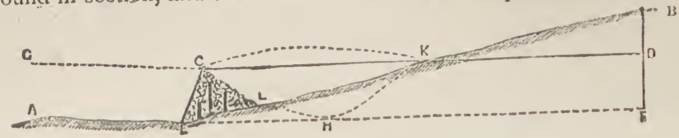


FIG. 551. EXAMPLE OF LEVELLING GROUND.

Practical example of levelling.

desired to make. Had it been necessary to level a site for a house, the whole mass of earth comprised within the dotted line E F and the lines E B, B F would have to be removed and conveyed elsewhere, or had the contour been that of the dotted line G C H K all that would have been necessary would be to fill the depression C H K with earth taken from K D B; but in this case it is desired to construct a level platform in place of the sloping ground rising gently from the level A E. The first thing to be done is to take such rough masses or materials as can be got out of K D B and pile them in a line along E L, so as to furnish something in the shape of a containing wall to hold in the earth afterwards thrown into C L K. If there be no stones or rough earth in K D B that can be made available, it is a good plan to drive a few rows of short stakes along E L, as shown by the dark lines in the diagram, to aid in sustaining the earth, which must be dug out and thrown, if the distance be short enough, or wheeled if it be too far to throw, until the hollow C L K has been filled, and all the earth removed from K D B. As the earth is thrown between the stakes it should be rammed with the rammer to give consistency to it, and prevent it from falling out on to A E. Of course, as earth occupies more space when loose than when it is solid, when all the soil has been removed from K D B, it will rise above the level as shown by the dotted line C K. It must,

How to hold earth in place.

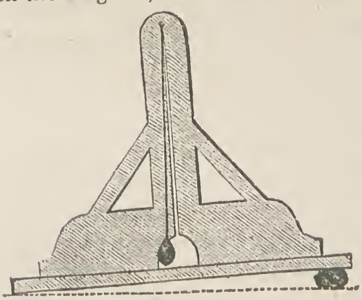


FIG. 552. PRINCIPLE OF THE A LEVEL.

however, be left to settle and consolidate. The face of the bank C E must be made up with some of the earth, and covered with turf; and when the protuberance at C K has settled sufficiently, trial must be made that the level is true by means of the A level, which has been described in another part of this work, and whose principle is shown in fig. 552. In fact, the A level, and the other level for trying uprights, already described in section 293 in Household Carpentry and Joinery, should find a place among the amateur's building plant.

The A level, etc.

1096. Digging trenches for foundations, and sinking pits for any purpose, whether for a sawpit, or cellarage, or an ice-house, or a mushroom-house, or any other purpose for which it is necessary to go below the level of the ground, is comparatively simple. The area of the trench or pit must be marked out by stakes driven into the ground at each corner or angle, and the ground within the area thus marked out must be dug out and removed. Care must be taken to keep the sides of the trench perpendicular and the bottom level. This must be done by the aid of the A level and plumb level. The bottom of a trench or pit should be well rammed with a rammer to consolidate the earth, and thus render it better fitted to bear any stuff, whether concrete or brick, that may be laid in it as foundations for the walls above.

Trenches for foundations.

Mode of procedure.

1097. When a trench is dug for concrete it should be exactly the depth and width required for the concrete, but when the foundation is to consist of bricks or stones the trench must be made wide enough to allow room for working, and the space left on either side of the foundations subsequently filled in again with earth. For draining trenches are made in a different manner, as will be described presently. As trenches are shallow no support is required for the sides, but in sinking a pit in light, loose earth or gravel it may be found necessary to line it with boards to prevent it from falling in. The amateur will seldom, if ever, have to resort to this; and as it will be attended with much trouble and inconvenience owing to the necessity of keeping the boards in place by timbers stretching across the pit as shown in fig. 553, it will be almost better for him to open out the pit very widely indeed at the top, and allow the sides to shelve to the bottom as shown in part at A B and

Trenches for concrete, etc.

Trenching in loose earth.

Supporting sides with boards.

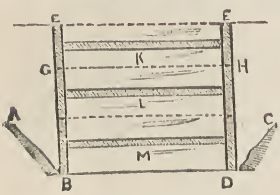


FIG. 553. BOARDING IN PIT.

C D. The walls forming the side of the pit may then be put up in brick, stone, or concrete as at B E and D F, which in the diagram represent the sections of the boards placed to hold up the earth at G and H. If the pit be not of any great size, the struts, K, L, M, used to support the boards at the side may also be made available for sustaining the boards at the ends, as shown by the dotted lines, as the boards used for this purpose at the sides being thick will not bend under the weight and pressure of the earth behind them. Of course the boards round the top are placed in position first of all, and the remainder in succession as the excavation is carried deeper and deeper. This precaution is generally taken in well-sinking to prevent any falling in at the sides, which would be fatal to the man at work.

Description of method employed.

1098. When the soil is clayey it may be converted into "ballast," as it is called, which affords a useful material for making roads and mixing concrete. A fire is made of culm or small coal, cinders, ashes, etc., which is covered in with lumps of clay. More fuel is scattered over the clay, and then clay on the fuel, alternate layers of each being deposited one over the other until a large heap is made. The mass takes some time to burn through, but when the fire has burnt out the clay has assumed the appearance of fragments of brick rubbish. Reckoning coal at from 15s. to 18s. per ton, this material will cost from 2s. to 2s. 6d. per cubic yard. It is useful for paths where no better hardening material can be obtained.

Ballast: how to make it.

1099. When the subsoil is heavy and retentive of moisture, as clay is, it is desirable to relieve the soil above of superfluity of water by draining. The materials employed in covering drains are very varied — brushwood, rubble, stones, bricks, and pipes being all in use. The best and cheapest drains, however, are drain-pipes, which are now obtainable everywhere on moderate terms. The implements used in drainage are spades, varying in size so as to go to the bottom of a deep drain without taking out more soil than is necessary, sloping to the point and slightly rounded

Draining wet soil.

Materials and implements.

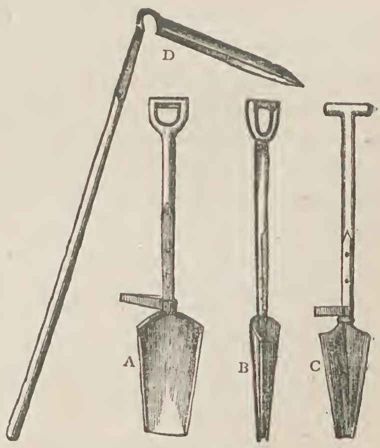


FIG. 554. DRAINING TOOLS.

so as to make a circular cut; a spoon-like implement for lifting the loose soil out of the bottom of the trench, and a level. Illustrations of the spades, etc., are shown in fig. 554.

1100. We will first consider the method of preparing a trench for drainage, and then the different kinds of drains that are in general use. The width at the surface of the drain should be laid out neatly with a line and reel, and the first spit removed of a width in which a man can work conveniently. From this extreme or greatest width at the top the trench will gradually taper towards the bottom, the sides sloping and approaching nearer and nearer until there is only width enough to lay the drain-pipe. If the ground in which the drain is made slopes along the direction of the drain so that one side is lower than the other, the earth as it is removed should be thrown to the lower side; first, because it is easier for the workman, and, secondly, to prevent any slip of the soil that might occur if heavy rains fall while the work is in progress. Having dug out the soil to within 8in. or 9in. of the bottom, as shown at *a a* in fig. 555, for which the draining spade A (fig. 554) is generally used, the bottom being of a width convenient for the workman, the remaining space is required to be much narrower, and is excavated by means of the bottom tools B and C (fig. 554), the workman supporting himself during the work of excavation on the shoulders or ledges *a a* (fig. 555), the bottom being made smooth and level by means of the scoop D, of which several sizes are in use. In making a drain care should be taken that, while the bottom is left smooth, it should have a proper fall in its whole length, and that if there is no natural fall in the land, one should be produced by making the head of the drain shallower than the outfall.

Preparation of trench for draining.

FIG. 555. TRENCH FOR DRAINING.

Different tools for trenching.

1101. There are various ways of laying out the drains in ground, according to the configuration of the surface. If the ground have a uniform slope, as is often the case with garden ground, it will be sufficient to lay parallel lines of 2in. pipes at a distance of from 15ft. to 20ft. apart, provided always that pipes are used in making the drains. When the land slopes slightly on either side to a depression in the middle, a main drain of 3in. pipes should be laid along this depression from the head to the outfall, and

Laying out drains in ground.

lateral drains of 2in. pipes entering the main drain and connected with it by junction-sockets and elbow-joints. It is useless to attempt to give more precise directions, as the construction and disposition of drains must in every case depend on the nature of the soil and the contour of the surface. The depth, too, will also depend upon circumstances, but a main drain will vary in depth from 3ft. to 4ft., being shallowest at the head and deepest at the outfall, while lateral drains may range from 2ft. 6in. to 3ft. All lateral drains should enter a main drain obliquely and not at right angles, and the fall should be greater when the lateral approaches the main drain than at any other portion of its course. From 15ft. to 20ft. should be allowed between the feeders to a main drain. In fig. 556 an illustration is given of an elbow-joint A, connecting the feeder B with the main drain C, whose fall is in the direction of the arrow. Drain-pipes vary in length from 12in. to 15in., and in price from 10s. to 15s. per thousand. Price lists, and any information that may be required, will be forwarded post free to any applicant by MR. JOHN MATTHEWS, *The Royal Pottery*, *Weston-super-Mare.*

Main drain.

Lateral drain.

Drain-pipes.

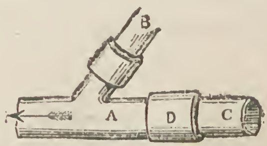


FIG. 556. ELBOW JOINT.

1102. Sometimes the drain-pipes are laid with collars, as at D—that is, short pieces of piping sufficiently large to receive the ends of two pipes, thus keeping them firmly in their place. These collars are sometimes perforated on the upper surface to admit the water. Sometimes the pipes are joined together by bands of tempered clay, which answers very well, but in this case the upper sides of the pipes should be perforated with holes for the reception of the water, so that the solid junction of the pipes is no detriment. It is not usual, however, to do more than lay the pipes end to end in a straight line, or just fit the end of one pipe into the socket made for its reception at the end of the pipe that comes next to it, if pipes of this construction are used. In this case no clay or cement must be used to bind the pipes together, but at the junction of any feeder with a main drain the union should be carefully made by clay or cement where permanent drainage is expected.

Connection of pipes by collars, etc.

1103. The following general remarks on drainage and the various methods of constructing drains may prove useful, and afford some useful hints and suggestions to the amateur who may be intending to effect the drainage of his garden or any small piece of ground, either by himself or with the aid of a labourer only.

Remarks on draining.

1104. The depth should vary with the nature of the soil. If the subsoil is a stiff retentive clay, care should be taken to go no deeper than is necessary to be out of the way of the spade in digging and trenching, or to give the necessary fall; for water does not readily filter through clay, and draining land is for the purpose of drawing water quickly off the surface to prevent stagnation and to admit of going on it immediately after rain; therefore to lay drains so deep into the clay that water would be weeks in filtering to them would be the height of folly. If the ground be more porous, let the drains be three, but not more than four, feet deep. Having got the trenches ready, lay the pipes, and cover them for a few inches with rough porous rubbish, or broken crockery, or any such material, and the drains will be effective and permanent. An excellent plan is to lay soles or flat tiles, and on these to set half-pipes or bridge-pipes, which are of a tunnel shape, and on these to lay the rough stuff and fill in with earth, which should not be rammed or trodden very tight, but merely allowed to settle. If the trenches are merely filled with rough stuff, brickbats, etc., to the thickness of a foot or so, the drainage will be effective but not so permanent; even brushwood will do, and sometimes last for many years in clay soils. When drainage is roughly effected in this manner, the cost of drain-pipes is of course saved.

Stiff subsoil.

Porous ground.

Filling in trenches.

1105. The drain shown in fig. 557 is cut through a stratum of porous soil, P S, for about 2ft., and through the clay subsoil, R S, about 30in. At the bottom of the trench are placed pieces of flat stone, A A A, one on each side supporting a horizontal stone laid over them. On the top of this stone, a layer of round stones, brickbats, etc., B, is placed, over which the soil C is replaced. In fig. 558 is shown another form of drain suitable for retentive soils. The construction is the same, two stones or tiles, C, C, are placed against the sides, resting on a stone, B, laid on the bottom of the trench. Over these another stone, A, is laid horizontally, and on this the soil is replaced, the rougher and looser parts being undermost, and in immediate proximity to the stone. In fig. 559 we have the most perfect of all drainage. A circular drain-pipe, C, is laid at the bottom of the trench, which should, however, have been carried down into

Practical example in draining.

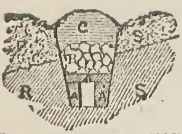


FIG. 557. DRAIN FOR POROUS SOIL.

FIG. 558. DRAIN FOR RETENTIVE SOIL.

FIG. 559. BEST KIND OF DRAINAGE.

the substratum R C. Over this pipe are laid, first, the roughest rubble, B, available, on which a slate or tile, A, is placed, which will prevent roots penetrating downwards to the pipes as well as the earth from falling in through the stones. If the pipe rested on the surface of the close tenacious subsoil, as shown in the illustration, the water would be diffused over the surface of the substratum and could not enter the drain-pipe. If, however, the drain-pipe is sunk into the subsoil as it should be, the water trickles from the surface of the substratum first into the rubble at B, and then into the pipe. In fig. 560 is shown the most convenient arrangement for porous soils. A serviceable flat stone or tile is laid in the bottom of the trench, resting on a solid smooth bed, gently falling from the higher ground or head of the drain to the outfall. On this stone is placed a semicircular tile, D, a succession of which forms an arched way extending uninterruptedly along the whole length of the drain. Over this is thrown a layer of rough stones and rubble, B, 6in. or 8in. thick; over this a tile, slate, or flat stone, to keep out sand, roots of trees, and other destructive agencies; and over the whole the surface soil is again filled in.

Laying circular drain-pipe.

FIG. 560. ARRANGEMENT FOR POROUS SOILS.

Semicircular tile on flat stone.

1106. The following table, showing the number of tiles or pipes required to drain one acre of land at different widths, is taken from "Laxton's Price Book."

1. *Level ground or ground slightly sloping.*			2. *To cuttings and embankments laid at an angle 45°.*		
Distance between rows in yds.	12in. Tiles.	15in. Tiles.	Distance between rows in yds.	12in. Tiles.	15in. Tiles.
4	3630	2904	4	5704	4356
8	1815	1452	8	2732	2178
12	1210	966	12	1815	1452

In estimating the number of tiles or pipes required for a small garden, all that the amateur need do is to measure the length of his drains in feet. He will then require as many pipes as there are feet if he use 12in. pipes, or four pipes for every 5ft. if he use 15in. pipes. He should order a few more than the number actually required to provide against breakages.

Tiles required to drain acre of land.

1107. It is but seldom that the amateur will have to turn his hand to making a hedge. Embankments will be more in his way, in order to obtain variety in his garden, if it be sufficiently large to be laid out with winding walks and diversified by mounds and clumps. Nothing more need be said here about embankments, as the process to be adopted has been sufficiently described for all practical

Hedges and embankments.

purposes in section 1095. A few words on hedges and narrow banks may, however, be desirable.

1108. A narrow bank with steep sides covered with turf, and planted along the top, say, with bush-roses at intervals of about 4ft., and dwarf plants such as pinks, etc., on either side along the intervals, is always pleasing, either as a border to a croquet-ground or bowling-green, or as a line of demarcation between one portion of a garden and another. A section of such a bank is shown in fig. 561. A substratum of rough stuff should be piled on the ground on either side, as shown at A A, to afford support to the earth B that forms the interior of the mound. Against the exterior earth should be thrown up and beaten flat with a spade, to afford the better lodgment for the turf C C, with which the sides must be covered. An angle of 30° will be found convenient for the slope of the sides of such a bank as this, but it may be less if desired. When placed in position, the turf should be well watered and beaten, and then left alone until the grass has rooted into the earth beneath. There are many plants, especially pinks, that will thrive on such a bank or raised border. Near large towns, turfs may be procured from any land that is given up for building purposes, or any gardener will obtain them and deliver them at the rate of 8s. per hundred—that is to say, at 1d. per turf, which should measure 3ft. in length and 1ft. in width.

How to make a hedge or bank.

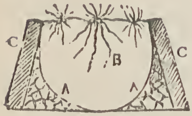


Fig. 561. Narrow bank.

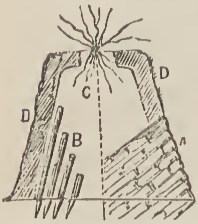


Fig. 562. Low hedge.

Plants in centre of bank.

1109. In making low hedges, or a foundation for a quickset-hedge, it is necessary to proceed on a different plan. If rough stones are plentiful in the neighbourhood, and can be procured at a low rate, the space which the hedge is to cover must be marked out, and a V shaped trench cut out, on which the stones may be heaped together, sloping inwards on either side, as shown at A in fig. 562; the interstices being filled with earth, well washed in with water, that no space between the stones may remain empty. On this foundation, which may be carried up to the height of 2ft. or even 3ft. if necessary, earth may be piled as at C, faced with turf, D. When the whole has had time to settle and consolidate, quickset or white thorn may be planted along the top of the hedge, as shown in the diagram. If there be no possibility of obtaining stone or any kind of material that will answer the purpose as well, additional support and strength

Foundation for quickset-hedge.

may be given to the hedge by driving in rough stakes, as shown at B, one row within the other, the stakes of one row being placed in the intervals of the stakes in the row before or behind it. The stakes may be from 12in. to 18in. apart. Earth should be thrown within the stakes and rammed together somewhat tightly, after which the middle may be filled up, and the bank carried to the height required. The entire surface of a hedge made in this way must be covered with turf, D, but when it is constructed with stones, as shown at A, small-leaved ivy, primroses, creeping-Jenny, and plants of a similar description may be planted in the interstices, producing a pleasing effect, and hiding the greater part of the rough stone-work from view in course of time. The amateur will find many means and methods of varying the mode of construction here described.

Use of stones and stakes.

Staked hedge must be turfed.

Ornamentation of stone foundation.

1110. Concrete, now so much used in forming the foundations of buildings of every description, and even the walls themselves, is a mixture of cement and sand, gravel, broken stones, brick rubbish, or similar materials in the proportion of one part of cement to five or six parts of any of the other ingredients that are used in its manufacture. Good lime is often used instead of cement, but the amateur, if he use lime at all, is advised to use cement with it in equal parts. The cement, being the substance that binds the gravel ballast, etc., together into a solid mass impervious to water, is technically called the *matrix*, and the substance that is added to the lime is called the *aggregate*.

Concrete: what it is.

1111. It may be said that any waste material of a hard nature may be used as aggregate in making concrete, sand and gravel of all kinds, including pea or fine gravel, pit gravel, river gravel, Thames ballast and sea beach, burnt clay, broken chalk, ashes, cinders, and coke, lime chippings, flints, old stones and bricks, especially when broken, broken earthenware and stoneware, and rubbish from the brickyard may all be used. Slag, too, the refuse of the iron furnaces, can be made available whenever it can be obtained. Thus, there is no part of Great Britain or Ireland without some kind of material that can be used for concrete. It should not be used in too large sizes. Pieces about the size of stones ordinarily used for metalling and mending roads, or such as will pass through a ring of 2½in. in diameter, are best suited for the purpose when the material is broken up on purpose for making concrete.

Materials for making concrete.

1112. Any of the various cements in general use may be used in the

manufacture of concrete, but the amateur is recommended in all cases to use Portland cement, which is three times as strong as Roman cement. The following information with regard to cements is taken from Spon's "Architects' and Builders' Pocket Book of Prices and Memoranda":

Various cements in use.

1113. "*Hydraulic cements* contain a larger proportion of silica, alumina, magnesia, etc., than hydraulic limes. They do not slake after calcination, and some of them set under water at a temperature of 65° in from three to five minutes; others require as many hours. *Roman cement* is made from a lime of a peculiar character found in England and France, derived from argillo-calcareous kidney-shaped stones, termed 'Septaria,' and when mixed thick, it solidifies in a few minutes, either in air or water."

Hydraulic cements.

Roman cement.

1114. "*Portland cement* is made in England and France from an argillo-calcareous deposit, which is burned and ground up for cement in its natural state without the addition of lime. Strong Portland cement is heavy, weighing 110lbs. to the bushel. Weak cement is light. Strong cement is of a bluish-grey colour, and sets slowly. Weak cement sets quickly, but has too much clay in it, and is of a brownish colour. The cleaner and sharper the sand, and the less water used in mixing the cement, the stronger it will be." A cask of Portland cement contains 4 bushels, nominally, it holds 5 cubic feet, and weighs 3¾ cwt.

Portland cement.

Strong and weak cement.

1115. When made into stucco for covering a wall, the following table will show the extent of surface that a bushel of cement may be made to cover when used pure or with various proportions of sand, and at certain thicknesses:

Stucco for walls.

1 bushel of cement will cover	1⅛ yds.	1 in. thick	1½ yds.	¾ in. thick	2¼ yds.	½ in. thick
1 bushel of cement and 1 of sand	2¼ ,,	,,	3 ,,	,,	4½ ,,	,,
1 bushel of cement and 3 of sand	3½ ,,	,,	4½ ,,	,,	6¾ ,,	,,

1116. Portland cement may be bought in small quantities at the oil-shops at the rate of ½d. per pound, 3½d. being generally charged for 7lbs. done up in a paper bag. As cement will not keep, especially in a moist atmosphere, the amateur, when he requires a small quantity for repairs, is recommended to buy just so much as he wants and no more. The prices of cement per ton and bushel are compiled from Laxton's and Spon's Price Books: the price per ton is the prime cost at the works; the price per bushel such as the builder charges, the builder's profit being added to the cost price.

Prices of cements.

	Per Ton.	Per Bush.		Per Ton.	Per Bush.
Portland Cement, Best... ...	50/	... 2/9	Dorking Lime (36 bush.) ...	11/	... —
Do. Second Qual.	42/6	... —	Do. Ground ...	12/	... 10d.
Roman Cement	42/6	... 1/6	Selenitic Cement	28/	... —
Lias Cement	30/	... —	Atkinson's Cement	—	... 4/0
Blue Lias Lime, Lump ...	15/	... —	Keene's Cement, Coarse ...	—	... 4/3
Do. Ground ...	18/4	... —	,, ,, Fine	—	... 7/

1117. In making concrete, it is important, in the first place, that the aggregate, be it what it may, should be deposited on a clean place—if on old boards, as scaffold boards, so much the better—so that no dirt may get mixed up with it. The concrete itself should be made on boards, nailed together on ledges or on three putlogs placed on the ground parallel to one another, forming a rough platform. The aggregate and the cement or lime used as the matrix must then be placed on the boards, the aggregate being measured out first, and the proper proportion of concrete to the aggregate being also méasured out and thrown upon it. The heap is then wetted with water poured over it from a large water-pot fitted with a fine rose, and the whole is then mixed until the materials are thoroughly amalgamated.

Concrete should be made on boards.

1118. The amateur who desires further information respecting the manufacture and uses of concrete will find everything that he can require or desire in Mr. Thomas Potter's "Concrete: its use in Building, etc." In speaking of the method of making concrete, Mr. Potter gives the following directions:—

"Concrete: its use in building."

1119. "The aggregate having been placed in the larger measure, the cement by one or other of the ways described deposited on the aggregate, the measure or measures are removed by a workman at each corner lifting them perpendicularly by the handles, leaving the materials on the boards in the form roughly of a cone or pyramid. Two men, one on each side of the heap, then begin to throw the materials to the opposite side of the mixing-board; another, standing by the heap now forming, further incorporates the ingredients by working them backwards and forwards with the hook, until the heap has been reformed. The same process is then repeated, and by this the materials are replaced where at first deposited. Having now been turned over and raked 'twice dry,' the operation is again gone through in the same way, but with the help of a fourth man, who stands behind the heap and adds the water from the watering-pot to such portion as the two men who are shovelling are immediately about to remove. This makes three times turned and raked. Once more repeated finishes the process, and the concrete is then

How to make concrete.

ready to be deposited where required, after having been turned over and raked twice dry, once during the process of watering and once after.

1120. "It is essential that certain precautions be observed in mixing the concrete :— **Precautions to be observed.**

(1) "The water should be added to that portion of the material the two 'shovellers' are working upon, and not to the mass indiscriminately, as so doing would cause the cement to have time to sink through the interstices of the aggregate previous to attaining partial solidity. **Where water is to be added.**

(2) "Water should be added—as much as needed—during the third turning, not afterwards. **When it should be added.**

(3) "The amount of water applied must be regulated according to the purpose for which the concrete is intended. For foundations, arches, etc., where infringement can be practised, only as much as to cause slight cohesion between the materials is necessary; but for walls, between frames, and similar objects, it must be in a kind of semi-liquid condition. **The amount to be added.**

(4) "The 'shovellers' must turn the concrete completely over when in the act of casting it from one heap to another—not take it up in the shovels—and deposit it without changing the position of the ingredients." **Turning over the concrete.**

1121. From the foregoing description, it is manifest that the amateur will require aid if he desires to mix concrete on a large scale for any purpose, but in making it in small quantities he can dispense altogether with assistance from others. The following instructions taken from Spon's "Workshop Receipts," may be followed whenever the operator requires to mix a small quantity only : **Assistance necessary when mixing large quantities.** **Mixing small quantities.**

RECIPE.—"Take five parts of gravel and sand to one part of fresh burned stone lime, ground to powder without slaking, and measured dry. Well turn and shovel together, with sufficient water to slack the lime into the state of very thick water. Chips and small pieces of stone may be added with advantage."

1122. In filling a trench with concrete thus prepared in order to serve as the foundation for brick or stone work, or even for a concrete wall, it is necessary that the concrete should be thrown into the place in which it is to be with some degree of force. To ensure this in laying the foundations of houses, the concrete is usually thrown into its resting-place from a stage raised from 6ft. to 8ft. above the level of the ground. This is **Filling trench with concrete.**

done in order to give solidity to the mass, for it is evident that the wet conglomeration of cement and gravel will lie closer together when thrown from a height some feet above the level of the ground than if it were merely shovelled into the trench from the level of the ground itself.

Why thrown in from higher level.

1123. We must now pass on to garden walks of different kinds, the making of which comes under the province of the excavator. The chief thing to be done in every case is to provide a solid but yet porous substratum, which will afford sufficient support to the materials of which the upper part of the walk, or rather its surface, is made, and yet allow of the rapid passing away of the water that may fall on the walk in the form of rain. Of course we are now supposing that the walk is to be made in the ordinary way, and coated—if a road, with broken stones, technically called "metalling," and if a garden path, with gravel.

Garden walks, paths, etc.

1124. The course of the path or road must first be marked out with stakes, and the surface soil removed to the depth of a foot or 18 inches, if there be no lack of materials to fill it. From one-third to one-half the depth must then be filled up with rough stones, brickbats, clinkers from the brickfields, slag and scoriæ from the ironworks, and any coarse, hard rubbish that can be gathered together; the greater part of the remainder must then be filled up with coarse gravel, shingle, etc., which may be mixed with a little earth to give consistency to the whole, and finally coated with gravel to the depth of two or three inches, which must be constantly rolled with a heavy garden roller until the path is hard and solid.

Marking out course.

Mode of making path.

1125. The section of a garden walk made in this manner is shown in fig. 563, in which A represents the stratum of brickbats, etc., B the layer of gravel or shingle intermediate in size between the brickbats below, and the gravel, C, above. The top of the gravel, and indeed of every walk, should be gently rounded in order to allow any rain that may fall to trickle off on either side, whence it soaks away into the earth at E, E. Supposing, as is sometimes the case, that the ground is of a loose, porous character, or wet and marshy, and therefore not calculated to afford a solid basis to the roadway, it is a good plan to make the trench deeper, and lay faggots or brushwood along the bottom before throwing in the rough rubbish. The faggoting

Construction of garden walk.

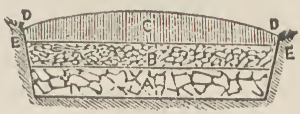


FIG. 563. SECTION OF GARDEN WALK.

not only furnishes a firm and durable foundation for the pathway or roadway, as the case may be, but it also helps to drain the ground on either side of the walk, carrying it off to the lowest part, if the walk slopes from higher ground to lower.

1126. In some cases it is desirable to have a solid facing to a garden walk so that it may be impervious to rain, and in this case it is of importance that the surface of the walk should be rounded —higher in the centre, and sloping down on either side. The water will escape into the earth or turf by which the walk is bordered, or, if desired, a gutter can be formed to carry the water to a tank formed for its reception in some part of the garden. The gutter may either be moulded in the material of which the path is made, or it may be constructed below the surface, like a drain, and hidden from view. In this case gratings should be inserted along the edge of the path at intervals to allow of the escape of the water into the gutter.

Solid facing to path.

1127. In making a path with a solid surface, the modes that come best within the compass of the amateur are the two kinds known as tar paving and concrete paving. *Asphalte pavement*, which consists of a surface of asphalte brought to a semi-fluid condition by means of heat and spread over a concrete bed, requires plant in the shape of furnaces, etc., for heating the asphalte, and should be laid by men accustomed to the work. It need not, therefore, be further described.

Asphalte pavement.

1128. *Tar pavement*, although making it is a very dirty and unpleasant piece of work, and best left to practised hands, may be easily laid by the amateur. The surface of the walk should be removed to the depth of three or four inches and well beaten. Some thick coal tar should then be poured over a heap of shingle or coarse gravel, and the whole worked together with a spade, or crooked fork, until the gravel is thoroughly impregnated with the tar. This composition must be spread over the surface of the walk, and rolled down with a heavy roller. Another mixture must now be made of tar and finer gravel, or sifted ashes from the dust-bin, and a thin layer spread over the layer of rougher stuff first put on. Fine sand or gravel must then be sprinkled freely over the top of this, and the whole once more rolled with the roller or beaten flat with the back of the blade of a spade if no roller be available.

Tar pavement.

1129. *Concrete pavement*, which is far cleaner to work than tar pavement, is put down in the following manner:—The earth is first taken off the surface of the path to the depth of 8in. or 9in., and the

shallow trench thus made is filled up to about two-thirds or three-fourths of its whole depth with stones, broken brickbats, and coarse gravel, well rammed together so as to present a level surface. Portland cement must now be mixed in a tub with water until it is of the consistence of thick cream or custard, and poured over the gravel. This must be spread about with a bast-broom to level the surface and send it into the interstices of the first rough coat of stones and gravel. On this a coating of Portland cement and gravel, mixed with water, must be spread, bringing the surface very nearly up to the height of the path ; and when this has hardened, a finishing coat must be put on of clean, sharp sand and Portland cement in equal parts, and brought, when mixed with water, to the consistence of mortar. The surface must be rounded and brought to smoothness by the aid of a float, a piece of wood with a handle at the back, something like a laundress's iron, but longer, with which plasterers finish the surface of walls and ceilings. No one should be allowed to tread on the surface thus made until it is perfectly dry and hard.

Concrete pavement.

Finishing coat.

1130. The cost of garden walks may be estimated as follows, at per square yard :—The ordinary gravel walk, when properly made, at 1s. 8d. ; tar pavement, consisting of gravel mixed with tar, rolled and sprinkled with sand, at 2s. 9d. ; and concrete pavement, consisting of concrete faced with cement, at 3s. 6d. Of course these prices must be considered as approximate only, as allowance must be made for the differences that will be found in the price of materials in different parts.

Cost of garden walks per square yard.

1131. Well-sinking the amateur will never meddle with. It is a dangerous and difficult business. The most useful kind of well for the amateur is the Patent Tube Well, which can be sunk in the earth by mechanical means and withdrawn again whenever it is desired to do so. The tube well is a pipe with a conical point, perforated to admit of the entrance of water. It is inserted into the earth, and then rammed downwards with machinery made for the purpose. When the whole length of the pipe is inserted into the soil another length is screwed on, and the process is repeated as before until water is reached, when the water enters the holes in the nozzle of the pipe and rises to the top.

Well-sinking.

Patent Tube Well.

1132. Considering the benefit that accrues from having a well of this kind on the premises, the prices charged, even by the builder, for fixing them are by no means high. The charges, according to depth, and inclusive of pumps, pipes, and labour,

Prices of tube wells.

are as follows :—10ft., £6 10s.; 15ft., £7 10s.; 20ft., £9; 25ft., £10 10s.; 30ft., £12 10s. Trial borings to determine the presence of water are charged for at the rate of £1 1s. each trial. All information respecting the tube well may be procured from the proprietors of the patent, MESSRS. LE GRAND & SUTCLIFF, *Magdala Works*, 100, *Bunhill Row, E.C.* It is generally known as the Abyssinian Tube Well, because water for the troops engaged in the Abyssinian War of 1868 was provided by this means, by the engineers accompanying the expedition, at every halting-place.

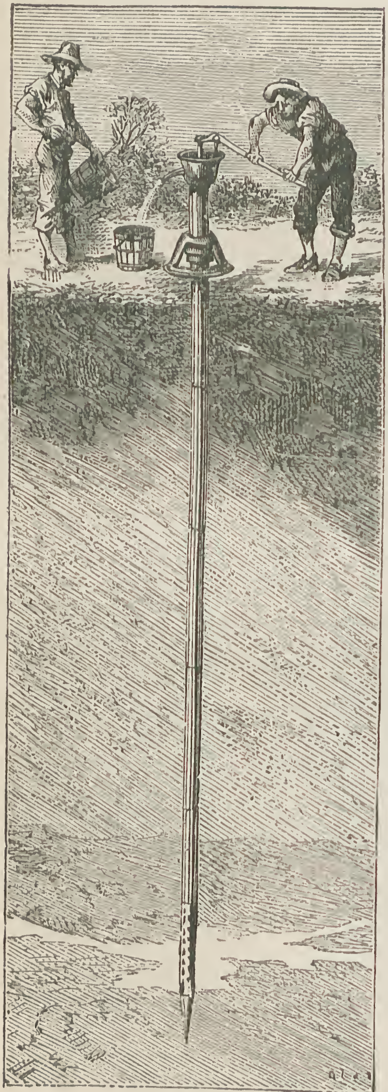


FIG. 564.
ABYSSINIAN TUBE WELL.

1133. The appearance of the well itself, when complete, and the position of the tube under ground, from the surface to the water, is shown in fig. 564, and the method of driving the tubes into the ground in fig. 565. The former explains itself and requires no comment. In the latter the tube with the steel-pointed end is shown, with the apparatus by which it is supported, on the one hand, and driven into the earth, on the other. A is the tube itself, which passes through the cap F and the cylindrical weight D. To the cap F are attached two iron legs B, B, which are secured by the stays E, E, to the carriage by which the

Appearance of tube well.

Mode of sinking tube.

machinery and pipes are conveyed from place to place. Two grooved wheels are attached to the upper ends of the legs B, B, over which are passed ropes, fastened to the weight D. A movable stop C is clamped to the tube at a little distance above the ground. The weight D is raised by the ropes and allowed to fall on the stop C, and this operation is repeated until the stop is brought close to the surface of the ground by the entrance of the pipe which is forced into it by the repeated blows of the weight D. The stop is then unclamped and removed higher up the tube, and the next portion of the tube between the earth and the stop is forced into the ground in the same manner until water is reached. As soon as this is done a disintegrating pump is applied to the tube, in order to clear away the sand and grit that has entered the holes in the steel nozzle, and give free passage to the water; and when all is clear the permanent pillar pump is attached, as shown in fig. 564.

FIG. 565. MACHINE FOR DRIVING TUBES OF TUBE WELL.

Improvised driving machine.

1134. If the amateur is so situated that it is not possible to procure the proper tubes and apparatus, it is clear that a driving machine may be easily improvised to carry out the object in view, and common iron pipes, such as those used for the conveyance of gas from the main pipe into the house, be driven into the earth, a steel conical nozzle perforated with holes having been fitted to the first pipe by any ordinary blacksmith.

1135. To go further into details respecting the various kinds of

work performed by the excavator is manifestly impossible on account of space, and the number and variety of subjects in connection with the building art yet to be considered. It is, moreover, unnecessary, as our object is not to write an exhaustive work on building processes, which would, if properly treated, assume the form and extent of an encyclopædia; but merely to bring under the notice of the amateur-artisan such work as he may be able to accomplish himself without aid from others, or to see carried out under his superintendence.

Completion of remarks on excavating.

CHAPTER III.

BRICKLAYING, ITS VARIOUS BRANCHES : TOOLS, PROCESSES, ETC.

ricklaying requires Practice—A Level Surface Necessary — Brick Wall must be Perpendicular—A Level must be used in Preparing Foundations—Tools requisite in Bricklaying—Mortar mixed on Boards—Large and Small Trowels—Second-hand Trowel—Mortar-board : how to Make it—Improvised Trowel—Iron-work, etc., to be preserved—Ramming Earth for Foundations—Jerry-builders' Foundations—Thickness of Walls : how Described—Foundations for Walls of different Thickness—Measurement of Brick-work—Rod of Brick-work—Quantity of Bricks required—Yard of Brick Nogging—Mortar : how Made—Proportions of Materials —Strength of Mortar made by the Old Builders—Cost of Brick-work : how to Calculate—Old Bricks suitable for Amateur—Classification of Bricks—Names applied to Bricks—Colours of Bricks—Cost of Mortar—Prices of Lime, Road-grit, etc.—Cinders or breeze in Mortar—Approximate Prices of Bricks—Fundamental Rule in Bricklaying—Breaking Bond—Headers and Stretchers—Bonds used by Bricklayers—English Bond—Flemish Bond—Points demanding attention in Bricklaying—Method of Building Wall—How the Bricklayer Builds—Stretching the Line—Spreading Mortar—Adjusting and Fixing Brick—Closers : their use in Bricklaying—Illustrations of Use of Closers—Assistance in Breaking Bond—Formation of Quoin or Angle—How a Corner is Turned—Tie in Brick Wall—Complete Exposition of Bricklaying not possible here—The Reveal : what it is—Construction of the Reveal—Hoop iron in Brick Walls—Opening for Door or Window—The Brestsummer—How Beam is Hidden from View—Stone Lintel—Arches in Building—Definition of Arch—Construction and General Principles—Piers and Springing Stones—Crown and Keystone—Haunches and Voussoirs—Intrados and Extrados—Working drawing of Arch Necessary—Gauging Bricks or Stones of Arch—Result of Faulty Construction—Centering of Arch —Construction of Framing—Application of Centering various—Backing of Flat Arch—Formation of Flat Arch—Segmental Arch—Construction of Flat Arch—Filling up or Backing of Flat Arch—Mortar for Bricklaying—Method of Making Mortar—Sand required—River Water—Effect of Clay on Lime—Stove in Workshop—Chimney or Flue in Wall—How to construct Longitudinal Flue—Dearn's Wall--Saving of Material in Hollow Wall—Bricks : how to Save—Simple Fireplace and Flue—Mode of Construction—Jambs and Hearthstone—Rod iron as Bars at Bottom—Rod iron as Bars in Front—Chimney-bearer—Chimney-breast —Trivet on Top Bar of Grate—Porosity of Bricks—How Bricks become Damp—Prevention of Damp in Wall—How to Stop rising of Damp—Damp Courses of various Kinds—Cure of Dampness in Brick Wall difficult—Insertion of Damp Course—Damp in Upper part of House—Stoppage in Pipes, etc.—Preliminary Process—How to Finish the Work—Solution of Naphtha and Shell Lac—Remedy for Damp Walls—Tar on Exterior of Brick Walls—Portland Cement—Solution for Brick and Stone—Laminated Lead—Pointing Brick Walls—Flat Pointing—Tuck Pointing— Plasterer's Putty—Pointing required by Amateur—Mode of Procedure—Reduction of Surface of Brick-work—Roofing and Paving—Plain

Tiles and Pantiles—Dimensions, etc., of Bricks—Principle involved in Roofing—Explanation of Principle—How to replace Broken Slates—Roofing with Pantiles—Number of Tiles to Square—Disposition of Laths—Bricks used for Paving—How Paving is done—Paving with Cobble Stones—Coloured Paving Tiles, etc.—Estimate of Cost of Paving—Cost of Encaustic Tiles—Builders' Prices for Tiles—Prices of Paving Tiles—Fixing Coppers and Ranges—How Coppers are Set—Back of Register Stove—Prices of Fire Tiles—Fire Clay: where to get it—Preparation and Use of Fire Clay.

1136. BRICKLAYING is in itself an apparently simple process, inasmuch as it consists merely in laying or disposing regular and similar rectangular pieces of baked clay one upon another, layer upon layer, until a certain height is reached, spreading a composition of lime and sand called mortar between each layer, which hardens and connects the bricks together in a tolerably solid mass. There is, however, much more skill in bricklaying than is apparent at first sight, and really good bricklaying cannot be done without practice any more than other building processes.

Bricklaying requires practice.

1137. First of all it is necessary to determine that the surface, whether of earth or concrete, on which the superstructure of bricks is to be reared, is perfectly level, as, if this be not the case, it cannot be expected that the courses of bricks will be in regular lines. Attempts will be made to overcome this by making the layers of mortar thicker in one part than another in order to bring the courses level after a bit; but such a mode of proceeding as this will be found objectionable and detrimental to the solidity as well as the appearance of the wall, because if the mortar could be preserved in its extra thickness in parts it would present a large breadth to be acted on by the weather, and the actual experience of the builder of the wall would be that, as additional weight was imposed on the soft mass by each additional course of bricks, it would *squeeze out* and cause irregularity in the upper courses.

A level surface necessary.

1138. Thus much for the wall in its length. It is also clear that a want of due level in the surface on which the wall is built cannot fail to cause it to incline a little to one side or the other, while it is absolutely necessary that the inner and outer face of a wall should be perpendicular or at right angles to the plane surface on which it is raised.

Brick wall must be perpendicular.

1139. It is almost unnecessary to observe, after what has been said in the preceding chapter about clearing trenches for foundations, that the level of the surface on which a wall is built must be ascertained by means of the A level, and the accuracy of the perpendicular of the wall by the upright level or plumb-bob.

A level must be used in preparing foundations.

1140. The tools requisite in bricklaying are a large strong steel trowel, with which mortar may be spread and bricks chopped asunder or reduced to any extent that may be required in order to produce a perfect bond. Mortar is carried up the ladder, and on to the part of the scaffolding where the bricklayer is at work, by his attendant labourer, in a vessel called a hod, which is shaped like a box, open at one end and cut across diagonally and fitted at the bottom angle into a short pole. The amateur will not want an appliance of this kind, as he will not attempt to carry a wall to any height. He will, however, want a small trowel for pointing, and a piece of wood about 10in. or 12in. square fixed on a wooden peg which serves as a handle by which to hold it.

Tools requisite in bricklaying.

1141. With the exception of a piece of boarding, consisting of boards about 1in. thick, nailed on to ledges on which to mix mortar close to the scene of operation, and on which to carry it thither from the main mass, the tools required by the amateur are figured in the accompanying illustration. No allusion is made to the levels, as everything which is necessary to bring under the reader's notice respecting the construction and the use of these has been said already. The large trowel, which must be of steel, and which rings clear and resonant as a bell when a brick is struck with it, is figured at A, in fig. 566. The small trowel, used for pointing or filling the spaces between the bricks with new mortar or even cement, is shown at B, and at C the mortar-board on which the mortar or cement is placed, and which is held in the left hand by the handle below while pointing. New trowels cost, the larger one 2s. 9d., and the smaller one 1s. 4d.; but as workmen in times of need are often unhappily compelled to part even with their tools to raise a little ready money, trowels may often be bought for 9d. or 1s. at the marine-store dealers or unredeemed pledge shops, which are to be found in all parts of the suburbs of London, and the back streets of most large towns. The mortar-board the amateur can make for himself. It is simply a square piece of inch board put on a handle, which may be cut

Mortar mixed on boards.

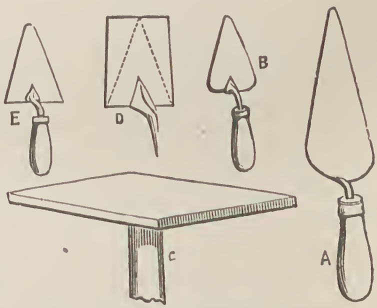


FIG. 566. TOOLS USED IN BRICKLAYING, ETC.

Large and small trowels.

Second-hand trowel.

Mortar-board: how to make it.

from an old broomstick, though a piece of ash is better. It should be keyed and wedged into the board and strengthened by angle irons or small brackets as at A A, in fig. 567. These irons may be procured at any ironmonger's for 2d. or 3d. a piece. (See Section 791.)

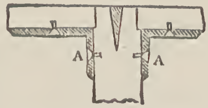


FIG. 567. ANGLE-IRONS IN MORTAR-BOARDS.

1142. To show how easily tools may be made which will answer every necessary purpose, the writer has shown at D and E in fig. 566 how he managed to make a small trowel for pointing, which he has used for some years in doing all the work of this kind that he finds it necessary to do, and which is used occasionally by workmen who come to do odd jobs in which the use of a little cement is necessary, and who do not happen to have a trowel with them. It happened that he required to do a little pointing one day, and had been unsuccessful in his search for a small trowel at the rag-and-bone establishments in his neighbourhood. Being thoroughly nonplussed for the moment, he happened to catch sight of the iron blade of a child's toy spade represented at D, which a little son of his had broken and thrown aside. Its adaptation to the purposes of a trowel was clear. All that had to be done was to cut off the corners as shown by the dotted lines so as to alter the blade from a square one to a triangular pointed form. This was effected by the aid of a three-square file ; the tang was then beaten straight and inserted into the handle—one of wood, japanned black—of an old dust-pan, and the result was a handy little trowel as shown at E, which has since done the maker good service.

Improvised trowel.

1143. And here it may be permitted me to say a few words to the amateur on the necessity of saving everything of the kind, and all iron-work, brass fittings, such as the roses of handles, etc., that may come in his way, and which are generally looked on as rubbish and only fit for the dust-hole. I keep a box—a small set of drawers such as are used by grocers, seedsmen, etc., would be better, because articles could then be assorted and stowed away according to their several purposes—into which all iron-work, handles, etc., are thrown, to be used again when occasion requires, and my genuine experience is that—

Iron-work, etc., to be preserved.

Everything comes useful once in seven years,

as the old saying runs, or at all events pretty nearly so, for if it comes useful again in the course of one's lifetime the assertion can be said to have received its proof.

1144. Provided that the earth under the proposed foundations has

been well rammed so as to impart the necessary degree of solidity to it, or that a substratum of concrete has been laid, and that it has been ascertained that the earth or concrete, as the case may be, is perfectly level, the foundations of the wall must be laid.

Ramming earth for foundations.

It is unfortunately too often the habit of builders—or rather jerry-builders—to use the worst possible description of bricks for the foundations. The amateur, on the contrary, must take care to see that he has sound, hard, strong bricks for this purpose. Bricks that are rough and unfit for the upper part of the wall are good enough for the foundation as long as they are moderately square and hard, and therefore all the less likely to soak up water.

Jerry-builders' foundations.

Thickness of walls: how described.

1145. It will be clear even to a novice that the foundation of a brick wall must exceed the thickness of the wall itself in all the courses, from the lowest to that from which the wall springs. The thickness of a wall is described by the number of bricks or parts of bricks to which it extends. Thus a partition wall in brick nogging, or of the *breadth* of a brick, is described as being half a brick thick, and the extent of thickness ranges upwards from this, as one brick thick, one and a half bricks thick, two bricks thick, two and a half bricks thick, three bricks thick, etc. Now a brick is accounted to be 9 inches

Foundations for walls of different thickness.

FIG. 568.
ONE INCH.

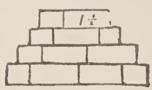


FIG. 569.
ONE AND A HALF INCHES.

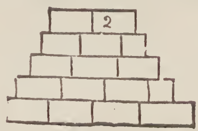


FIG. 570.
TWO INCHES.

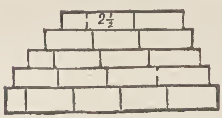


FIG. 571.
TWO AND A HALF INCHES.

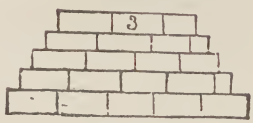


FIG. 572.
THREE INCHES.

SECTIONS OF BRICK WALLS OF VARIOUS THICKNESSES.

long, 4½ inches broad, and 2½ inches thick, the breadth being half the length, and the thickness rather more than half the breadth, or one-fourth the length ; an arrangement which renders bricks more convenient to use, owing to the correspondence and harmony of proportions in length, breadth, and thickness. The equivalents of the thicknesses of walls above enumerated will therefore be, when ex-

pressed in inches, ½ brick = 4½in.; 1 brick = 9in.; 1½ bricks = 13½in.; 2 bricks = 18in.; 2½ bricks = 22½in., etc. Diagrams of sections of foundations of these various thicknesses are shown in figs. 568, 569, 570, 571, 572. The arrangements of the bricks in these various diagrams being perfectly clear and apparent, no explanation need be given with regard to them.

1146. Before proceeding any further it may be desirable to say something about the measurement of brick-work, and the space that a certain number of bricks will fill when built together. The following memoranda on these points are taken from "Laxton's Price Book."

Measurement of brick-work.

1147. A rod of brick-work is 272 feet superficial, 1½ brick or 13½ inches thick, called in London the standard thickness, to which all brick-work of whatever thickness is reduced. One rod of reduced brick-work is equal to 306 cubic feet or 11⅓ cubic yards. To one rod reduced 4,352 stock-bricks are reckoned, and 4 courses of bricks are estimated to make 1 foot of brick-work in height. When laid dry—that is, without mortar—it takes 5,371 bricks to one rod, and 4,900 bricks in wells and circular cesspools. These calculations are without allowing any waste, which is more than amply compensated in dwelling-houses by not deducting flues and bond timbers; in such work 4,300 stock-bricks, or 4,500 place-bricks are sufficient for a rod. A rod of brick-work contains 235 feet cube of bricks, and 71 feet of mortar (4 courses to 1 foot), which will weigh on an average calculation 15 tons. It takes 16 bricks to make a foot cube of reduced brick-work, and 7 bricks to form a foot super of facing. One yard of brick nogging takes 30 bricks on edge, and 45 bricks flat, but one yard of paving requires 36 stock-bricks laid flat and 52 on edge. If paving bricks are used, which are thinner than the ordinary brick, 36 are required when laid flat, and 82 when laid on edge.

Rod of brick-work.

Quantity of bricks required.

Yard of brick nogging.

1148. Bricks are cemented together with mortar, which is a mixture of lime and sand brought to a pasty consistence by the addition of water. When it is desired to make brick-work as strong and durable as possible, the mortar should be made of cement, or a little cement should be added to the lime. The following proportions and memoranda are taken from "Laxton's Price Book."

Mortar: how made.

1149. Lime and sand, and cement and sand, lose about one-third their bulk when made into mortar, and lime and Portland cement both require one-third their bulk of water to mix. For a rod of brick-work, 71 cubic feet of mortar will be required, as

Proportions of materials.

it has been said, and to make this quantity are required 1½ cubic yards of chalk lime and 3 of road drift or sand; or 1 cubic yard of stone lime, and 3½ of sand; or 36 bushels of cement, and the same quantity of sharp sand. From this it is apparent that the proportion of mortar or cement when made up, to the lime or cement and sand before made up, is 2 to 3. Lime, or cement and sand, to make mortar, require as much water as is equal to one-third of their bulk, or about 5½ barrels for a rod of brick-work built with mortar.

Strength of mortar made by the old builders.

1150. The mortar used by the old builders was far more durable than the mortar used in the present day. It hardened into a mass, which offered greater resistance to the weather than even the stone itself that it was used to cement together. A remarkable example of this is to be seen in the tower of the church of South Huish, about four or four and a half miles from Kingsbridge, in Devonshire, and close to the coast between Thurlestone and the Bolt Head. Exposed to the full action of the wind and rain and spray from the sea, the face of the tower fronting seawards is regularly honeycombed from top to bottom, the stones being hollowed out to the depth of 1 inch or 1½ inches, while the mortar between them stands out in ridges as hard and firm as it was when it had first set.

Cost of brick-work: how to calculate.

1151. The cost of brick-work may be easily calculated from the above memoranda. There are many different kinds of bricks variously named from their colour or quality, or the place where they are made; but it will only be necessary to give the prices of place-bricks and stock-bricks, which will be most generally used by the amateur in such work as he may do. Place-bricks cost on an average about 45s., and stock-bricks 37s., per 1,000, delivered to the purchaser; but it must be noted that a variation in these prices will be made according to the greater or less distance that the bricks have to be carted from the place where they are made to the place where they are to be used.

Old bricks suitable for amateur.

When an old brick building has been taken down, the amateur may buy very good bricks for his purpose at from 15s. to 25s. per 1,000, and in the vicinity of London there are certain places which may be found out by a little inquiry, where these and other component parts of houses that have been pulled down may be bought at a low rate.

Classification of bricks.

1152. There are many different kinds of bricks which may be divided into three classes, as follows:—1. Bricks used for walling; 2. Fire-bricks; and 3. Clinkers or Paving-bricks. There are two methods of burning bricks for walling, and they are accordingly called "kiln-burnt bricks" and "clamp-burnt bricks;"

the former being baked in a kiln, and the latter burnt in a huge stack or *clamp*, containing from 500,000 to 1,000,000, piled together in a square or rectangular mass, with fuel in the form of cinder ashes or breeze scattered between the layers. About one-tenth of every clamp is lost by the unequal action of the fire and breakage. When the clamp is sufficiently baked, the bricks are sorted into classes known as *cutters*, fine close-grained bricks, rather soft and better suited for work in which the bricks require cutting; *picked stocks*, or bricks of a uniform red tint; *paviours*, or hard bricks fit for paving; *common stocks*, or ordinary bricks; *grizzles*, or *soft bricks*; and *burrs*. The bricks also vary in colour according to the degree of heat to which they have been exposed. The kiln-baked bricks, also called *malms*, are made of a finer clay, and slowly burnt in kilns. They are of a pretty buff colour and uniform in tint, but they are not so durable as the common bricks. Their colour is due to the quantity of carbonate of lime that they contain, and it is this ingredient that renders the Suffolk bricks so pale, indeed, almost white, in colour. The fine red bricks made in the Midland counties are chiefly used for the better class of buildings, or for arches over doors and windows, in which the bricks must be gauged or brought down by rubbing so as to fit together at certain angles. Fire-bricks and paving-bricks also are made of clay, which contains a great quantity of silicate of alumina and but a very small proportion of lime or iron. The silicate of alumina fuses when the bricks are burnt, and this causes them to become very hard and durable.

Names applied to bricks.

Colours of bricks.

1153. It is also necessary in making calculations of the cost of brick-work to know the cost of mortar. This will depend entirely on the prices of the ingredients of which it is made, and these will differ considerably in different localities. The following prices of lime and cement are taken from Spon's "Architects' and Builders' Pocket Book." They are the prices charged by builders, unless it is noted that the price is the prime cost. Some prices of bricks of various kinds are also quoted from the same authority.

Cost of mortar.

1154. Chalk lime (as supplied in Kent) by the yard or hundred is 13s.; but per bushel, 1s. Stone lime (as supplied in Devonshire) is 16s. per hundred, and 1s. 2d. per bushel. In the immediate neighbourhood of a kiln, in any locality, lime can of course be procured at a lower rate than those named. Blue lias lime is charged 24s. per yard. Sand or road grit varies very much according to the locality and the ease with which it can be procured. Road grit may be valued at 4s. per yard, or 4d. per bushel; and sand at an

Prices of lime, road grit, etc.

average of 5s. or 6s. per yard, or 6d. per bushel. The prime cost of Portland cement, the best for the amateur's purpose, as it has been said, is 2s. per bushel. Mortar when supplied by a builder is charged at 7d. per hod, and a hod contains about half a bushel, which brings the cost to about 1s. or 1s. 2d. per bushel. The amateur should never use sand from the sea-shore in making mortar; it is excellent for all farm and garden purposes, but the presence of salt from the sea-water renders mortar made of it liable to attract moisture in damp weather. If good, clean road sand cannot be got, the best thing to use is sand from the nearest gravel-pit; one or the other can always be obtained. Finely sifted cinder ashes may be mixed with lime, but this will of course impart a dark colour to the mortar. The jerry builder, who is by no means particular as to the quality of his mortar, will use a great deal of breeze, or siftings of the dust-heap, and even earth, with a very small modicum of lime, but this the amateur will be careful to avoid.

Cinders or breeze in mortar.

1155. The following are the prices per 100 at which bricks are quoted: place-bricks, 4s. 6d.; grey stocks, 5s.; red stocks, 6s.; malms, 9s.; cutters, 11s. 6d.; and red rubbers, 8s. The reader must always remember that the prices given in this book for materials of all sorts are to be taken as approximate only, and not as absolutely correct. Prices of building materials, as well as of everything else—gold and silver not excepted—rise and fall, and it by no means follows that what is the price to-day will be the price to-morrow. In all cases, however, the amateur is likely to find that the prices will be less rather than more than those stated.

Approximate prices of bricks.

1156. To proceed, however, with bricklaying or building with bricks, the amateur must remember that it is a fundamental rule that *in no two courses of bricks immediately contiguous shall the joints between two bricks in each course be continuous or form a straight, unbroken line.* This must be rigidly observed; the disposition of the bricks caused by the observance of this rule is called "breaking bond." A layer of bricks lengthwise throughout a wall is called a "course," and when bricks are so laid that their length is in the direction of the course, and their sides appear in the face of the wall, they are called "stretchers," and a course thus formed a "stretching course;" but when they are laid across the line of the course so that their ends or heads appear in the face of the wall, they are called "headers," and a course thus laid is called a "heading course."

Fundamental rule in bricklaying.

Breaking bond.

Headers and stretchers.

1157. There are three kinds of bonds used by English bricklayers, called respectively, "garden bond," "English bond," and "Flemish bond," and of these the last-named is most commonly used. There is another called "herring bond," but this is only used for the core or interior of walls faced with Flemish bond, and is formed by laying bricks diagonally between the faces and filling the interstices with mortar. It is a very weak mode of building, for the faces of the wall are not connected by bricks running transversely to the length of the wall, having their heads or ends in one face or the other, or in both if the wall be one brick or 9in. thick. Garden wall bond is only used for 9in. walls, and consists of courses of three stretchers and one header in regular succession throughout the course. English bond consists of alternate courses of stretchers and headers as shown in fig. 573. It is reputed to be the strongest bond used in bricklaying; but it is not so ornamental, and therefore pleasing to the eye, as the Flemish bond, shown in fig. 574, which consists of courses composed of headers and stretchers in alternation, every successive course being so arranged that the header in the course above rests immediately on the middle of the stretcher in the course below, while the stretcher in the upper course extends over the header in the course below it, and has its ends resting on the ends of the stretchers on either side of the header in question. The difference in the appearance of English and Flemish bond is clearly shown in the illustrations.

Bonds used by bricklayers.

English bond.

Fig. 573. English bond.

Flemish bond.

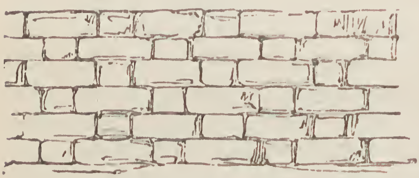


Fig. 574. Flemish bond.

1158. Having seen the general disposition of bricks in the face of a wall, there are yet certain points to be considered, and these may be summarised as the method adopted by the bricklayer in building a wall; the use and object of the "closer"; the manner in which successive courses of bricks are laid one upon another in building a brick wall; the construction of the quoin or corner when two walls are built at right angles to one another;

Points demanding attention in bricklaying.

and, lastly, the method of forming a reveal where the wall is interrupted in its regular course by openings for doors or windows.

1159. First let us take the general method adopted in building a brick wall, without any reference whatever to the bonding, as it will be better for the sake of rendering the process as intelligible as possible to proceed step by step in this manner.

Method of building wall.

1160. Suppose that two courses of bricks above the level of the

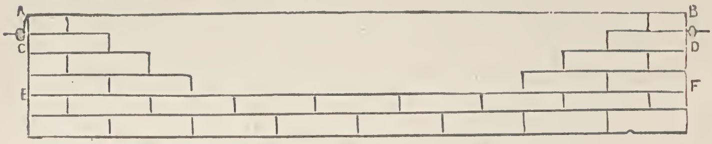


FIG. 575. METHOD OF BUILDING A BRICK WALL.

ground have been duly laid, as shown in fig. 575, the bricklayer then proceeds to build up four or five courses at each end of the wall, seeing by means of his level that the bricks are laid level, and that their outer faces are perpendicular. He then stretches a line A B along the length of the wall from A to B, securing it to the ends of the wall that he has just put up by means of two iron pegs furnished with the blades something like that of a dinner-knife, the flat part being thrust between the bricks and the peg projecting as at C, D, and furnishing a kind of spindle by which the string is stretched, and on which any surplus length is wound. It will be necessary for the amateur to have a pair of these. Two purposes are served by stretching the line; the topmost course of bricks are by its aid brought level with the bricks at A and B at either end, and by looking downwards and bringing the line directly over the edge of the bricks, shown by the line E F, he is assisted in making his wall truly upright or perpendicular. In laying bricks some mortar is first spread on the surface of the last course of bricks laid; the brick to be placed in position is carefully brought to the brick last laid, a little mortar having been thrown in with the trowel to cement end to end; pressure with the left hand is exerted until sufficient mortar has been squeezed out below to bring the brick's upper surface on a level with that of its neighbour, the operation being completed with one or two slight blows from the butt end of the trowel handle, the trowel itself being held in an upright position.

How the bricklayer builds.

Stretching the line.

Spreading mortar.

Adjusting and fixing brick.

1161. It by no means follows that a brick wall is the exact multiple of a brick, that is to say, that it contains an exact number of bricks in its length. It is to remedy any inconvenience resulting from this

that a portion of a brick called a "closer" is used; the closer also further serves as an aid in breaking bond. As a practical example of the use of the closer, and the way in which successive courses of bricks are laid, let us consider two courses of a 9in. wall in Flemish bond, which in all probability will be the utmost thickness to which the amateur bricklayer will extend his operations; these being limited perhaps to a 4½in. wall for a small greenhouse, or a 9in. wall for a larger greenhouse or shed.

Closers: their use in bricklaying.

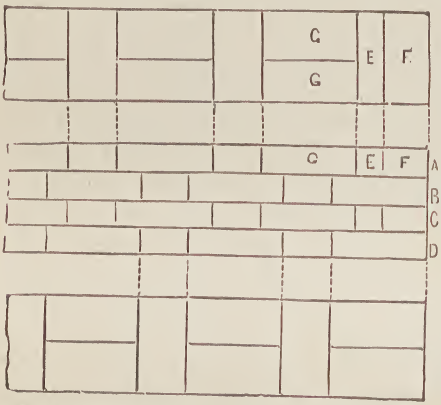
1162. The use and purpose of the closer, and the manner of laying successive courses of bricks in a 9in. wall Flemish bond, are illustrated in figs. 576, 577, and 578. In fig. 576 the elevation or appearance of the exterior face of the wall is represented, and in this case the interior face will be similar to the outer face. In fig. 577 is represented the plan of the course A, and consequently that of C; while in fig. 578 is represented the plan of the course D, and consequently that of B. These figures, in fact, are the plans of the alternate courses of bricks from the bottom of the wall to the top. Now to any one who will examine these figures carefully, connected as they are by dotted lines, it will be manifest that, if the courses A and C had had a stretcher placed next to the header with which they are commenced, and the courses B, D, had had a header placed next to the stretcher with which they are begun, the ends of the stretchers and the sides of the headers thus placed would have formed a perpendicular line in the face of the wall, thus breaking at the outset the fundamental rule in bricklaying, that the line of junction between two bricks in any course shall never be in the same straight line with the junction of two bricks in the course immediately above or immediately below it. To bring everything into fitting order the bricklayer has to cut a brick in half lengthwise, and this half-brick is inserted, as shown at E in figs. 576 and 577 between the header F and the stretchers G, G. A regular continuance of headers and stretchers

Illustrations of use of closers.

FIG. 577.

FIG. 576.

FIG. 578.



ILLUSTRATIONS OF USE OF CLOSER IN BRICK WALL.

can then be laid in the courses A and C, a rectification of breaking bond having been effected by the insertion of the *closer* E, which closes up the space that otherwise would be open, and renders the wall solid throughout. It is evident that, to bring all things right, closers must be inserted at the other end of the courses B and D, between the last stretcher and the last header. This the reader may easily work out for himself by continuing the drawing on paper, and finishing up the end in the same manner as that which is shown to the right of fig. 576.

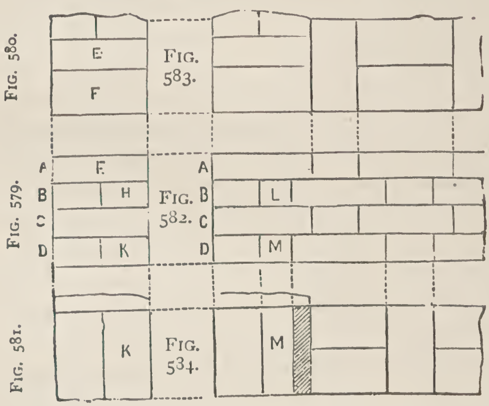
Assistance in breaking bond.

1163. Next in order it is necessary to give attention to the formation of a quoin or angle formed by the exterior and interior faces of a wall at right angles to each other. This will be best done by considering the appearance of the ends and sides of the bricks in fig. 576 and the accompanying plans of courses in figs. 577 and 578; turning the corner marked A B C D, and seeing what plan must be adopted so that the courses of bricks in each part of the wall meeting and joining at right angles in the corner may be firmly and securely bonded together.

Formation of quoin or angle.

1164. If the wall described in section 1162, and figured in elevation and plans in figs. 576, 577, 578, were simply a wall built in a straight line and finished off clean and perpendicular at either end, it is clear from a consideration of the figures just mentioned, that the end of the wall being 9in. or one brick thick would present the appearance shown in fig. 579 which is the elevation of the end of the wall, and figs. 580 and 581 which are the plans of the courses A, C and B, D respectively. Now the corner or quoin must be turned in such a manner that the ends of the stretchers A and C in the courses thus lettered will enter the new part of the wall, and that the ends of the first stretcher laid in the courses B and D shall enter the portion of the wall that is at right angles to the new part. How to manage this is clear from

How a corner is turned.



MODE OF FORMING QUOIN OR CORNER IN BRICK WALL.

the figures in illustration, remembering always how and by what regularity of bond was preserved in the other face of the wall. Instead of the stretchers H, K, shown in elevation in fig. 579 and in plan in fig. 581, closers L and M (figs. 582 and 584) must be substituted, and the wall carried on with regular succession of stretchers and headers in courses B and D, and headers and stretchers in courses A and C, until the end of the wall is reached, when courses A and C must be completed by the introduction of closers. The shaded portion of the stretchers next to, and butting against, the closer M in fig. 584, show the extent to which the tie is carried.

Tie in brick wall.

1165. In the course of a few brief sections it is impossible to give anything like a complete exposition of the mode adopted by bricklayers in laying bricks and connecting walls at right angles to each other. It is hoped, however, that what has been said on the subject is at least clear, and will prove sufficient for all practical purposes for the amateur.

Complete exposition of bricklaying not possible here.

1166. We have now to consider the formation of the reveal, revel, or revele—for the word is spelt in all these ways—the term applied in architecture to the side of an opening for a window, doorway, or the like between the framework and the outer surface of the wall. The appearance of the reveal from the outer to the inner face of the wall is in reality a rebate in brick-work, the framing of the window or that to which a door is hung fitting into the rebate.

The reveal: what it is.

1167. In actual building the frame for a door, provided that it be an outer door of the house, is fixed in position, and the bricks are built up to the wood-work, completely encompassing it, as it were; but the sash-frames of windows are not put in until the wall is built. In building a 4½in. wall the frame for the door is set up in position and the bricks built up to it and by it, the inner surface of the brick-work being flush with the inner part of the frame, while the outer surface generally projects a little way beyond it. Thus in a 4½in. brick wall, built round a door-frame 3in. thick, the inner surfaces of brick-work and frame being flush one with another, it is clear that the outer face of the brick-work would project 1½in. beyond the outer face of the frame. The construction of a reveal, and the manner in which it is made, is shown in fig. 585,

Construction of the reveal.

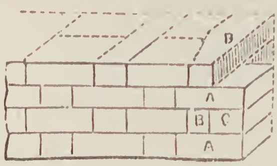


Fig. 585.
REVEAL IN BRICK-WORK.

in which the angle or recess into which a wooden framing may be fitted, whether it be a door-frame or sash-frame, is clearly shown. After all that has been said about closing in sections 1162 and 1164, it will be unnecessary to go into any detailed description. The closure at the reveal should be a bond closure. Thus supposing A and A to be whole bricks in the courses to which they belong, the wall being a 9in. wall in Flemish bond, B will be the bond closures, extending in their several courses from the outer to the inner face of the wall, and C, the half-brick completing the impost of the reveal. The face of the reveal is formed by the ends of the whole bricks and half-bricks in succession, and the face of the rebate or retiring portion by the bond closures and half-bricks inserted between each to make fair. Some bricklayers will use a three-quarter brick in place of the half-brick C and bond closer B, but if this were done it is manifest that there would be no bond in the whole of the ogee from top to bottom.

1168. Additional strength is often imparted to brick walls by laying long pieces of hoop-iron between any two contiguous courses of bricks.

Hoop-iron in brick walls.

The hoop-iron has the effect of a bond or tie running through the length of the wall and holding the bricks well together. The amateur, however, is not likely to require anything of this kind in the building that he may undertake. The use of iron laths or hoop-iron as bonding for brick-work is merely mentioned here to explain why pieces of this material are sometimes seen projecting from the wall of a finished house or building to which another is to be attached at some future time, after the manner of adjacent and attached houses in any continuous row.

1169. Having formed an opening in a brick wall for a door or window, as the case may be, the next thing to be considered is how

Opening for door or window.

to bridge over the opening so that, if necessary, the wall may be continued above it throughout its entire length. The simplest method that the amateur can adopt is to lay a piece of wood of the thickness of one or two bricks, according to the length to be bridged over, and the extent of walling that is to be raised above it, from pier to pier, and proceed to enclose it and build over it with bricks, taking care that the timber used is of such a length that the breaking bond throughout the wall may be properly observed. The method of doing this is clearly shown in fig. 586, in which A B is the

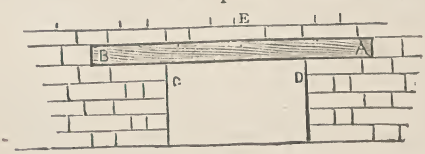


FIG. 586.
TIMBER OVER OPENING IN WALL.

timber, brick thick, laid on the piers C, D to sustain the weight of the bricks above at E.

1170. This mode of procedure is adopted in building in providing a resting-place, at once strong and sufficiently rigid to prevent any sagging in the middle, for the superincumbent weight of the wall that is piled above it, in the case of shop-fronts and projecting bay windows, when the width of the opening to be bridged over is considerable. The beam, or brestsummer as it is technically called, is hidden from view by the facia of the shop-front, or by the roof or covering of the bay window, and so any unsightliness of appearance is avoided; but in house-building, if a piece of wood were left showing in the wall, as A B in fig. 586, it would look very ugly. To prevent this the space over a door or window is usually bridged over by a lintel in stone or an arch in brick. The stone lintel is merely a repetition of the timber A B in fig. 586 in a different material, but some skill has to be exhibited in forming the arch in brick.

The brestsummer.

How beam is hidden from view.

Stone lintel.

1171. There are many forms of arches used in building, according to the style of the work in progress, but for these and their construction the reader is referred to any standard work on architecture. Only three kinds of arches require mention here, and these are the semicircular arch, the flat arch, and the segmental arch; but before entering on the method of constructing these forms of the arch, it is necessary to say what an arch is, and draw attention to its various component parts.

Arches in building.

1172. In Beeton's "Dictionary of Universal Information" an arch is defined as "a structure generally of stone or brick in a curved form, over an open space, the pieces of which are arranged in a manner calculated to bind them closely together by the pressure of one against another, rendering them capable of supporting a great weight of masonry above them."

Definition of arch.

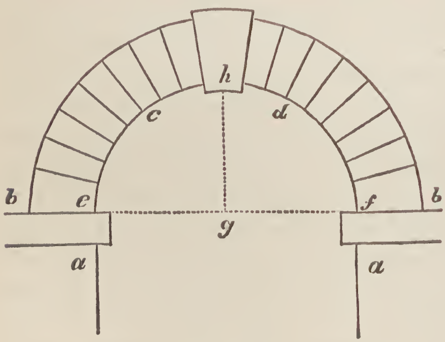


FIG. 587.
CONSTRUCTION OF SEMICIRCULAR ARCH.

1173. The construction and general principles of the arch is shown in fig. 587. In this *a*, *a* are the abutments or piers,

the columns or sides of masonry rising perpendicularly from the ground on which the ends of any arch are supported. The arch is said to spring from its piers, and the first stones, *b*, *b*, resting on the flat top of the piers on either side, are sometimes called the springing stones. The upper part, *c d*, of the arch is called the crown, and the stone *h* in the centre, in the form of a wedge which locks or binds together the bricks or stones that compose the arch, is called the key-stone. The sides of the arch, *e c*, *d f*, between the crown and the piers, are called its haunches or flanks. The stones or bricks which compose the arch, all wedge-shaped, smaller at the under end than at the upper, are called voussoirs, while the under ends of the stones are called the intrados or soffits, and the upper ends, the extrados or back. The line *e f*, joining the extremities of the arch, is called its span; and *g h*, drawn perpendicular to the span from its central point *g* to the centre of the bottom of the key-stone *h*, is called its rise. In practice there is no absolute necessity for any extension of the caps of the piers as shown at *a*, *a* beyond the face of the wall below, or for the projection of the key-stone above or below the extrados and intrados of the other bricks or stones that form the arch. It is often done for the sake of ornament, and then the caps and key-stone are frequently of stone, the latter being "vermiculated," as it is called, or indented with irregular hollows, or bearing a face, generally grotesque, in relief.

Construction and general principles.

Piers and springing stones.

Crown and key-stone.

Haunches and voussoirs.

Intrados and extrados.

1174. A careful examination of fig. 587 will show that the lines which mark the divisions between the bricks or stones of which the arch is made, all converge to the point *g*, and therefore that in the construction of any arch the stones must be cut, or the bricks "gauged" or rubbed down, to the exact shape required. To ascertain this a working drawing must be made in which the stones or bricks, as the case may be, are shown in elevation of the actual size required. By reference to the working drawing the workman can bring his materials to the exact shape required, and all that is necessary to be done is to put them in their places and cement them together. It will be readily seen that the greater the pressure above the arch the more firmly the parts of the arch are locked together; so that when the arch is once made, there need be no anxiety with respect to its inability to sustain any load that the amateur-artisan may place on it. His only care must be that his stones or bricks are so cut or gauged that the lines of

Working drawing of arch necessary.

Gauging bricks or stones of arch.

junction all converge accurately to a common centre. Exactness is necessary, for when cut too large, the span and rise of the arch will be larger than they should be, and when cut too small, and any attempt is made to bring the arch to the size desired by too much cement or mortar, the excess will be driven out by the load above as it is piled on, and the parts of the arch will be driven out of shape, and perhaps be displaced altogether, and the arch destroyed.

Result of faulty construction.

1175. It is manifest that some support must be provided for the parts of an arch while they are being placed in position. It usually assumes the form of a framework of wood, and is called the centering. A general idea of the method adopted in forming centering for small arches may be gained from fig. 588, which represents the centering required for a small semicircular arch. A B is a rectangular framework of pieces of wood roughly nailed together and strengthened by braces exactly filling the rectangular portion of the opening from the bottom to the level of the piers at the sides from which the arch is to spring. This framing is intended as a support for the actual centering of the arch, which consists of pieces of wood, C, D, E, F, nailed together and cut so as to form a semicircle a *little smaller* than the intrados of the arch, say with a radius less by 1in. than the intrados of the arch. Two pieces of framing of this description are made, and these are connected by cross bars, of which the *ends*, G, H, K, etc., are shown in the illustration all round the frames to which they are nailed. These cross-pieces must be 1in. in thickness, this being the difference between the length of the radius of the frames and that of the intrados of the arch to be built on the centering. The stones or bricks L, M, N, etc., when cut or gauged to size required, are then placed in position on the centering, the whole being wedged tightly together by the key-stone O. When sufficient time has been given to allow the mortar to set, the centering is removed, and the arch being properly loaded above is secure and stable.

Centering of arch.

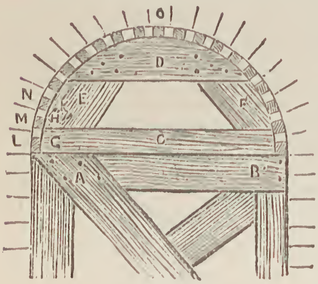


FIG. 588.
CENTERING FOR ARCH.

Construction of framing.

Application of centering various.

1176. The application of centering to arches of all kinds, barrel drains, etc., and the method in which it must be made, will now be sufficiently clear, and we may proceed to

the flat and segmental arches, so commonly seen over square openings, for doors or windows, whether wide or narrow, in buildings of all kinds, and in garden walls, etc.

1177. It will be manifest at once to the reader that there can be no bonding between the face of a flat arch and the back part, but that it must of necessity consist of two series of bricks, which are in no way connected or tied together as a wall is by headers running through its thickness when it is a 9in. wall, one end of the header appearing in the outer face and the other in the inner face. The formation of a flat arch will be best seen by examining figs. 589 and 590, of which the former represents the outer part and the latter the inner part of the arch. The segmental arch is formed in the same way. Practically speaking, there is very little difference between a flat arch and a segmental arch; the only absolute distinction is that, while the extrados and intrados of a flat arch are straight lines, those of the segmental arch are slightly curved lines or segments of circles of great diameter, or, in some cases, the intrados of the segmental arch is curved and the extrados flat.

Backing of flat arch.

Formation of flat arch.

Segmental arch.

1178. The mode of constructing the flat arch is shown in fig. 589, which also represents the outer face of the arch. The opening being carried up as far as may be necessary, namely, to the line A B, which is the line of the intrados of the arch, the brick-work is continued upwards for four, five, or six courses, according to the intended width of the arch, to the line C D, which is the line of the extrados of the arch, the bricks being disposed from A to C and from B to D, so as to form a slope against which the sides of the arch may be abutted. An angle of 60° is a convenient inclination, and if the lines C A and D B be produced towards each other, they will meet and intersect the perpendicular F E, through the middle of the opening, in the point E, the triangles C E D and A E B being equilateral triangles. The point E will be the point to

Construction of flat arch.

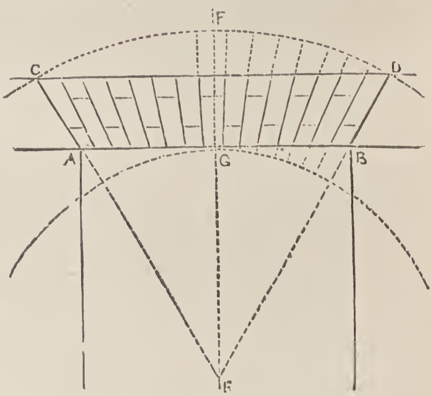


FIG. 589.
OUTER FACE OR FRONT OF FLAT ARCH.

which the lines of junction between the bricks used to form the arch converge; and a working drawing having been made in this manner, the bricks must be gauged or rubbed down until they are of the shape shown in the figure, and of such forms as will admit of their being placed together as shown in the drawing; a framework of centering is necessary for the support of the bricks while being placed in position. By drawing arcs through C and D, and through G, where the perpendicular F E is cut by the line A B, the intrados of the arch, and continuing the lines of demarcation between the bricks until they touch the arcs above and below, it is manifest that the flat arch is nothing more than a piece cut out of a wide semicircular arch, and that it is strictly from the principles involved in the construction of the semicircular arch that its stability is involved. It will be noticed that two courses of bricks are required to form the flat arch. It is necessary to have the lines of junction at the ends of the bricks shown in each course, parallel to the extrados and intrados of the arch for effect's sake, and the bricks are gauged accordingly. A brick in a slanting direction, with the ends cut so as to form with the ends of others a straight line, when put in position will not extend to more than three courses, and scarcely indeed to so much. Hence the necessity for combining a whole brick and part of a brick in each wedge as shown in the drawing.

1179. The bricks being placed on end and packed face to face do not extend to more than half the thickness of the wall, and it is manifest that the other half of the thickness behind the flat arch must be filled up. To effect this, a bar of iron, slightly curved, as A B in fig. 590, is rested on the piers, bridging the opening, and on this the brick-work at the back of the flat arch is built, as shown in the illustration. As soon as it is raised to the height of the extrados of the flat arch, the construction of the wall with headers in the direction of its thickness is carried on as before. It must be remembered that throughout the foregoing descriptions of arches we have taken the wall to be a 9in. wall, as that possibly will be, as we have said, the thickest wall in brick-work that the amateur will attempt.

Filling up, or backing of flat arch.

FIG. 590.
INNER FACE OR BACK OF FLAT ARCH.

1180. As it has been said before in the course of this chapter, the substance used for cementing bricks and stones together is called mortar

and some remarks have been made on the ingredients used in its composition. It may be convenient to the reader to give here a description of the method followed in making mortar, which is taken from the "Handbook of the Mechanical Arts," by Robert Scott Burn.

Mortar for bricklaying.

1181. "Lime, as used for building purposes, is obtained from several of the varieties of stone, marble, and chalk, termed limestones. It is prepared by burning or calcining the stone, thus drawing off the carbonic acid in which it abounds. After calcination it is reduced to a white powdery material, which greedily takes up water; it is then known as *quick lime*. In making mortar, fresh burned lime is taken from the kiln, and laid in a heap in a convenient place, and, sprinkling a quantity of water on it, the lime begins immediately to crack and fall down, steam issuing from the heap in considerable quantities—a high degree of heat being at the same time induced. On the completion of the process of decomposition, the lime is reduced to an impalpable powder, which goes by the name of 'slacked or slaked lime.' The slacked lime thus obtained is next to be well mixed with mortar, forming a paste, and, afterwards, have the proper proportion of sand added—*two-thirds sand to one-third of lime*. The sand used in mortar-making is of three kinds—pit sand, river, and sea. The first is obtained in pits, the latter from rivers and the sea-shore. River water is the best to use for mortar, but all waters known as mineral are to be avoided. The sea sand should never be used if it can be at all avoided, as walls built with mortar prepared from it are very likely to be damp. Mortar thus prepared sets very soon on being exposed to the atmosphere, but it is by no means calculated to stand under water or in very moist and damp situations. Where mortar is required for such work, hydraulic mortar or hydraulic cement must be used. . . . Clay burned and mixed with lime will enable the lime to withstand to a certain extent the action of water. Where a rich lime is obtainable, a hydraulic lime may be made by mixing twenty parts of dried clay to eighty of the lime. . . . Coal cinders ground to a powder and mixed with lime make a mortar which will be useful in wet or damp situations."

Method of making mortar. **Sand required.** **River water.** **Effect of clay on lime.**

1182. It is possible that the amateur may at one time or another desire to construct a small stove in a workshop, with a chimney to carry off the smoke, or even to make flues in walls, for the conveyance of hot air or to allow of the escape of

Stove in workshop.

smoke. Of course the thicker the wall the easier it is to make a flue, or longitudinal or upright passage, through it, as the case may be; but this may be done without difficulty even in a 9in. wall. A knowledge of the method may prove useful in the construction of forcing pits, greenhouses, and fowl-houses.

Chimney or flue in wall.

1183. Suppose, for example, that it is desired to construct one or more longitudinal flues in a brick wall. In such a case it is manifest that Flemish bond will not do, because the headers in each course would prove an obstruction. English bond must therefore be resorted to, which, as the reader will remember, consists of alternate courses of stretchers and headers. The wall must be built up in the ordinary manner, a layer of stretchers and a layer of headers alternately, until the height is reached at which it is proposed to construct the flue. The last course laid—which, it must be observed, forms the bottom of the flue—must be a course of headers. This course is shown at A in fig. 591, which represents the vertical and transverse section of such a wall as that which is being described, and which was introduced by a builder named Dearn, whence it is commonly called "Dearn's wall." On either side of the course of headers A, a line of stretchers B, B, laid on their sides is placed, and as a brick is 9in. long and 2½in. thick, a longitudinal opening D, 4in. wide and 4½in. high, is left in the centre of the wall. This opening is covered in by another course of headers, C, on which the wall is continued with a course of stretchers, and so on.

How to construct longitudinal flue.

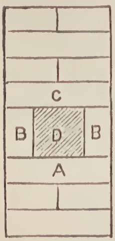


FIG. 591. DEARN'S WALL.

Dearn's wall.

1184. When a wall is built hollow, as above described, other ends are effected besides the mere making of a flue, for by the ventilation afforded damp is prevented, and there is a great saving of materials. It was, indeed, rather for these purposes than for making flues that the hollow construction of walls was proposed by Mr. Dearn, and is still followed in many cases.

Saving of material in hollow wall.

1185. If bricks were scarce and expensive in the locality in which the amateur lived, a saving of about one-third might be effected by building the wall from the level of the ground with alternate courses of headers and stretchers laid on their sides, as shown in fig. 591. The wall would not be so strong, it is true, as a solid 9in. wall, but if solidity were a *sine quâ non* it might be gained by filling the hollow at D with gravel concrete.

Bricks: how to save.

1186. Let us now proceed to the construction of a simple fireplace, with a flue or chimney above it for the escape of the smoke. This will

be found useful for warming a workshop or for heating a greenhouse in combination with flues running throughout the length of the walls; but in this latter case the stove must be constructed *outside* the greenhouse, but immediately adjacent to it.

Simple fireplace and flue.

1187. For the purpose now under consideration nothing is better or more simple than the plan given in the "Handbook of the Mechanical Arts," which we quote here, with a few verbal alterations, also giving the plan, elevation, and vertical section by which the text is illustrated. Mr. Burn says, after stating that in making this fireplace only bricks and mortar, and a few lengths of round rod-iron, ½in. or ¾in. in diameter, and 18in. long, are required:—"Let fig. 592 represent a vertical section of the fireplace, G G being the outside wall of the house. Build two projecting jambs, A B C D, as in fig. 594, 15in. from wall and 9in. broad on face C D; make these 8in. high. These projections should be built on a flat stone, previously placed on the floor to form the hearth, at the position of fireplace; the dimensions of this should be 3ft. by 2ft. If a stone of this size cannot be obtained, a platform of brick should be raised of the same size and of the thickness of an ordinary brick. The distance between inside of projections C D is to be 12in., and the back of the projection is to be made circular as in fig. 594. When the projections are raised to the proper height, place the lengths of rod-iron as in fig. 594. The first length is to be placed 2½in. from the outside face of projections C D. The depth to which the bars should extend is 8in. This will give the thickness of material at the back 4½in. After the bars are placed as in fig. 594, proceed to build up the projections, taking care to place from time to time the iron rods A, A, figs. 592 and 593, at proper distances, so as to form the front bars of the grate. The depth of place thus made for the fuel should be 6in.

Mode of construction.

Jambs and hearth stone.

Rod-iron as bars at bottom.

Rod-iron as bars in front.

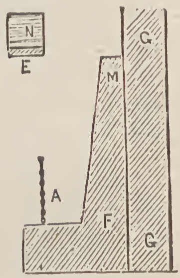


Fig. 592. Vertical section of fireplace.

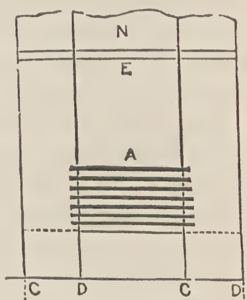


Fig. 593. Front elevation of fireplace.

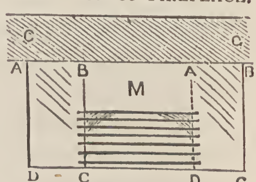


Fig. 594. Plan of fireplace.

1188. "Continue to build up the projections, rounding the back as in fig. 594, and sloping it as F M in fig. 592, until it is 26in. or 27in. high, measuring from top side of hearthstone. Across the top of projections place a chimney bearer of iron E, fig. 593, about ½in. thick, and 3in. or 4in. broad (or even two of less breadth, one in front and the other behind) ; the outside of this (if single) should be flush or level with the outside of projections, that is, 15in. from the inside line of wall. Proceed, after placing this, to build up the jambs, and continue them through the roof some 2ft. above it. It must be remembered that above the chimney bearer E E, the building is continued at N, figs. 592 and 593 ; this forms the front of the flue, or what is technically called the chimney breast. If the chimney bearer is 5in. broad, and the thickness of wall above it equal to this, and the back sloped from 4½in. at the bottom, F, to 2in. at M, the size of the chimney flue in the inside will be 12in. by 9in. This grate is constructed in the simplest manner, but will give satisfaction as warm and economical." Jambs may be added at the sides of the fireplace, whereon to rest a kettle, saucepan, glue-pot, etc., but the amateur will readily understand how to do this by decreasing the width of the fireplace, or giving more space between the jambs, if it be desired to keep the fireplace of the same width. For the amateur's workshop, it will be better to finish the front of the grate with a square bar at top, with a spike projecting upwards, on which may be fitted a trivet, as in a kitchen range, which will turn in any direction, and hold a glue-pot over the fire or away from it over the space in front of the bars.

Chimney bearer.

Chimney breast.

Trivet on top bar of grate.

1189. Bricks are very porous, and will absorb a considerable quantity of water ; indeed, it is said that an ordinary brick will absorb from one-fourth to one-third of its weight in water. The absorbent powers of any bricks may be tried by allowing them to remain for some time in a bucket or half-cask containing water, and noting their weight before and after immersion. It is the porosity of bricks that so frequently renders a house damp on the side most exposed to rain, and which causes a wall to remain damp for so long a time when the bricks have become thoroughly saturated by the overflow of a gutter used to carry water from the roof, or the bursting of a pipe.

Porosity of bricks.

1190. Bricks will also become damp by capillary attraction ; that is to say, when bricks are laid on damp ground, or ground which is nearly always in this condition, the water will rise through the pores of the bricks, extending upwards from course to

How bricks become damp.

course until a considerable space of walling is affected by it to the detriment of plastering and paper within.

1191. There are two things which manifestly require the attention of the amateur. First, how to prevent water from rising in a brick wall, especially if the wall in question forms part of a building erected as a workshop, or for some similar purpose; and, secondly, how to prevent the further rising of damp in a wall that has been built, and to counteract the bad appearance and ill effects resulting from its presence.

Prevention of damp in wall.

1192. The rising of damp in brick walls, or any tendency to this, can only be effectually stopped by the insertion of what is technically called a "damp course" in the wall, about the thickness of a brick *above* the ground line, or the line where the earth comes in contact with the brick-work. A damp course *below* the earth line is not so effective, because the bricks above it will absorb water, though not to so great a degree, from the earth that may be in contact with them. A simple and effectual damp course is one of slate, laid right through the wall as soon as it has been brought about a brick's thickness, or, in other words, 3in. above the ground line. The slates should be laid in Portland cement, and it is as well to lay two or three courses of bricks immediately above the damp course in Portland cement also. Asphalte is sometimes used; this is cheap and effective, but almost beyond the management of the amateur; and damp courses are made in glazed earthenware, pierced to allow of ventilation. Water cannot make its way through slate, asphalte, or glazed earthenware, hence the fitness of these materials for a damp course.

How to stop rising of damp.

Damp courses of various kinds.

1193. To cure dampness in a brick wall is far more difficult than to take proper means at the outset to prevent its appearance. There are many methods of doing this, but space will not permit us to dwell on more than three or four of the various modes that have been suggested from time to time.

Cure of dampness in brick wall difficult.

1194. If a house shows damp on all sides just where the walls rise from the ground, the only effectual cure is the insertion of a damp course just above the ground line. This can be done by degrees, and although productive of much dirt and discomfort while the work is in progress, it can be effected without any danger to the stability of the building as the course of bricks taken out for the insertion of the damp course can be removed by degrees, and replaced immediately by the damp course as the work goes on.

Insertion of damp course.

It will be understood that allusion is made to these matters, not with any idea that the amateur artisan can do any work of the kind on his own behalf, but that it is necessary for him to know something about it.

1195. If damp has been caused in the upper part of a house through the breakage of a water-pipe, or the stoppage of a gutter or waste-pipe, the first thing to be done is to remedy the primary cause of the evil. The overflow of water in rain-water pipes and guttering is often caused by the presence of a sparrow's nest, which acts as a dam to prevent the escape of water through the proper channel, and for this reason it is desirable to have the guttering and heads of all pipes inspected and cleared once a year, say about May or June. When a wall is thoroughly saturated it is well, if possible, to cut away the wet plastering on the inside a little beyond the limit to which the water has penetrated. If this is done the wall will dry out all the quicker, under the influence of the sun and air outside, and heat inside. The plaster must then be renewed, and the wall repointed outside. This is the most effectual way of repairing the damage, but it is not very often that a room can be vacated sufficiently long to admit of this mode of cure, and then other methods must be adopted.

Damp in upper part of house.

Stoppage in pipes, etc.

Preliminary process.

1196. As soon as the wet plastering has become moderately dry, it is an object to cover it with wall-paper to hide the damp and do away with the ugly appearance, even though the wall be cold and moist to the touch. It is yet sufficiently wet to destroy any paper that may be pasted over it. Sometimes an under coating of indiarubber paper so called, or tinfoil paper, is applied to the wet surface, and the wall-paper is pasted on this ; but the waterproof papers do not always answer the end for which they are specially intended, and the writer has found nothing better or more effectual than a solution of shell lac and naphtha, in the proportion of about four ounces of the former to a quart of the latter. This solution, when applied to the damp surface of the plaster, almost immediately hardens into a varnish impervious to water, and as soon as it is hard and dry, the wall-paper may be pasted to it. It gives a reddish colour to the wall, but this matters little as it is covered over and hidden from view by the paper. The smell of the naphtha is most unpleasant, but, fortunately, this soon passes off, and the inconvenience falls chiefly to the share of the workman who applies the varnish. This kind of work any amateur artisan ought to be able to do.

How to finish the work.

Solution of naphtha and shell lac.

1197. In Spon's useful volume of "Workshop Receipts," the following remedy—which is doubtless a good and effectual one—for damp walls is given. "RECIPE.—*Remedy for Damp Walls.* ¾ lb. of mottled soap to 1 gallon of water. This composition to be laid over the brick-work steadily and carefully, with a large flat brush, so as not to form a froth or lather on the surface. The wash to remain 24 hours to become dry. Mix ½ lb. of alum with 4 gallons of water; leave it to stand for 24 hours, and then apply it in the same manner over the coating of soap. Let this be done in dry weather."

Remedy for damp walls.

1198. A good coating of tar laid on to the exterior of a brick wall will prevent the entrance of damp; but this, although well enough for brick-work that is below the level of the ground, and hidden from view, is unsightly when above ground. Coal-tar should be used, and this should be heated in a tar-pot and applied hot. A small quantity of naphtha is sometimes added in the proportion of half a gallon of the naphtha to a gallon of tar; but the tar, plain and simple, will do quite as well. Another plan for walls above the ground-level is to mix one part of Portland cement with two parts of fine sand, and add water enough to bring the ingredients to the consistency of thick cream. Cover the brick-work with a couple of coats of this mixture, and when it is quite dry finish with a coat of paint. When the brick-work is below the ground-level, the earth must, of course, be removed, and the brick-work exposed to the air to allow it to dry a little before the tar, or any other coating that may be used, is applied. In such cases it is useful to dash fine sand against the tar, until the surface is thickly covered with it, and in a few days to apply another coating of tar, which should be sprinkled with sand as before. When the tar has hardened, the earth may be filled in.

Tar on exterior of brick walls.

Portland cement.

1199. The methods of preventing damp, above described, are such as come within the compass of any one of comparatively slender means; but for those who do not mind going to a little expense, the solution prepared for rendering brick and stone impervious to the weather by THE INDESTRUCTIBLE PAINT CO. (LIMITED), 27, *Cannon St., London, E.C.*, is recommended as being thoroughly effectual for the preservation of the material with which it is coated and the exclusion of damp. It is supplied by the company in quantities from one gallon upwards, at 6s. 6d. per gallon. This solution is, of course, best adapted for external application, though it may be used internally if desired. As a damp-proof coating for the walls of rooms, the "laminated" lead is

Solution for brick and stone.

Laminated lead.

said to be as effectual as the silicate solution is for preventing damp without. It is sold at the rate of 4d. per square foot, and is easily attached by small nails, supplied with the lead, to the surface which is to be covered. As soon as the lead is fixed in its place, the wall-paper can be applied to it in the ordinary way. Sometimes damp walls are covered with sheets of zinc, which are afterwards papered. If possible, however, the exclusion of damp should be effected by applications to the *outside* of the wall.

1200. When a brick wall has settled, and the mortar has hardened, the outer surface is usually finished by an operation technically called "pointing," which consists in raking out the joints between the courses and the bricks that compose each course, with the point of a trowel, and filling them up again with mortar specially prepared for the purpose.

Pointing brick walls.

1201. In building there are two kinds of pointing, distinguished as *flat* pointing and *tuck* pointing, the latter being more ornamental than the former. As soon as the joints have been raked out, it is usual to colour the brick-work with a wash prepared for the purpose, in order to produce a uniformity of appearance throughout the wall; but this, of course, need not be done when the bricks are good and of the same colour throughout. A mortar is then made consisting of lime, fine river sand, in the proportion of one part of lime to two of sand, and enough ashes from a blacksmith's forge—which are used on account of their fineness—to impart a blue colour to the mortar. The joints are then filled with this, and if left in this way, the pointing is styled *flat* pointing. If, however, *tuck* pointing is desired a thin white line is laid over the blue mortar, in the centre of the blue line, so as to show a narrow blue line on either side of the white line. The effect of this is shown in fig. 595. The mortar used for the white lines is what is technically called "putty," that is to say, plasterer's putty, and not glazier's putty, which is a different thing altogether. Plasterer's putty is fine white lime exceedingly well slaked with water, and, indeed, having so much water added to it that the lime is fairly held in solution. The water is then allowed to evaporate until the pasty settlement that is left behind is of sufficient consistence for working. The mode by which an even edge and regularity of width is given to the

Flat pointing.

Tuck pointing.

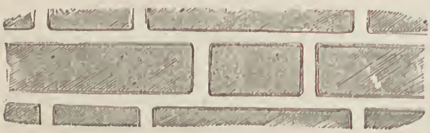


Fig. 595. tuck pointing.

Plasterer's putty.

white line is this. It is first laid over the blue mortar so as almost to cover it, and when it has nearly set, a straight-edge is applied, first to the top and then to the bottom of the white line, and the redundant putty cut away with a knife or any thin and tolerably sharp steel blade. When this has been done to all the joints, horizontal and vertical, the effect is produced of a white line on a blue ground.

Pointing required by amateur.

1202. The amateur artisan may occasionally require to point brick-work on his premises. It may be that he has built a shed against a brick wall, or in an angle formed by two walls, in which case one piece of walling will form the back and the other one side of the structure. Or he may have put up a small greenhouse in the same way, against either a part of one wall or portions of two. In either case, it is most likely that the old brick-work will want cleaning down and pointing.

Mode of procedure.

1203. The first thing to be done is to give the brick-work a good brushing with a birch-broom or bast-brush, which will have the effect of clearing away all the dirt and dust that is adhering to it. After this the joints must be raked out and a second brushing given to the wall. The best kind of mortar for pointing work of this kind is Portland cement and fine sand in equal parts, mixed to the consistency of very thick paste. This composition must be made up in small quantities at a time, so that it may not grow hard before it is used up. When mixed it must be placed on the mortar-board, which the amateur artisan will hold in his left hand, while he applies the mortar or cement with a small trowel held in the right hand. As he proceeds with the work, before each piece, or course, if done in single courses, has had time to harden, the surface should be worked over with a paint-brush dipped in water. This will impart a smooth surface to the cement, and fill up any little holes or depressions that there may be in the face of the brick-work, effectually disposing of any insect life that may lie lurking in the crevices.

Reduction of surface of brick-work.

1204. If the brick-work be very roughly laid, so that the ends and sides of some of the headers and stretchers extend beyond the proper plane of the wall's surface, it will be as well to reduce the prominent bricks to the ordinary level by chipping away the projecting parts with a cold chisel or a slater's hammer, which has one side shaped like a small hatchet, with a nick in it for breaking off projecting points of slate, as shown in fig. 596, and a hammer-head on the other side. The reduction of all projections,

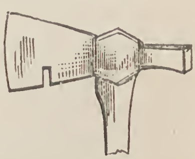


Fig. 596.
SLATER'S HAMMER.

which may be easily effected with one or the other of these tools, adds much to the appearance of the wall. This kind of hammer ranges in price from 2s. to 4s. After the wall has been pointed, and the face is dry, it may be lime-washed or coloured, according to taste or preference.

Roofing and paving.

1205. Although roofing is the peculiar province of the tiler and slater, and paving is usually executed by the pavior, yet the bricklayer is often called on to roof in a building with tiles, or to cover a floor with paving bricks, paving tiles, or even ordinary stock or place bricks. It may be as well, instead of giving a separate chapter to a description of paving, to speak of the mode to be adopted when bricks and tiles are used here, and of that of laying stone paving, etc., in the account of the mason's work. Covering in a roof with tiles may also be treated here.

Plain tiles and pantiles.

1206. Let us begin with the roofing, which may be done with plain tiles or pantiles, explaining that plain tiles are perfectly flat, while pantiles are curved in form ∽ something after the manner of the letter S. Tiles are hung by means of pegs to laths, called pantile laths, nailed on to the rafters of the house in a horizontal direction. The following are the length, breadth, thickness, and weight of bricks and tiles, taken from "Laxton's Price Book":

	Lgh. ft. in.	Bdh. ft. in.	Thk. ft. in.	Wght. lbs. oz.		Lgth. ft. in.	Bdh. ft. in.	Thk. ft. in.	Wht. lbs. oz
Stock or place bricks	0 8¾	0 4¼	0 2¾	6 12	10-in. tiles	0 9¾	0 9¾	0 1	8 9
Paving bricks	0 9	0 4½	0 1¾	5 0	Pantile laths—10ft. bundle contains 12 laths or	120 0	0 1½	0 1	4 6
Dutch clinkers	0 6¼	0 3	0 1½	1 8	Pantile laths—12 ft.	144 0	0 1½	0 1	5 0
Pantiles	1 1½	0 9½	0 0½	5 4	Plain laths	500 0	0 1	0 ¼	3 0
Plain tiles	0 10½	0 6½	0 0⅝	2 8					
Foot tiles	0 11¾	0 11¾	0 1½	13 0					

Dimensions, etc., of bricks.

It will be noticed that the dimensions of the place and stock bricks are placed somewhat less in length and breadth, and somewhat more in thickness, than previously stated; in calculating quantities of bricks, etc., it is as well to take the dimensions previously given.

Principle involved in roofing.

1207. The great principle involved in roofing is that there shall always be two thicknesses of the material used, whether in tiles or slate, except in the case of pantiles, where it is unnecessary. The object of this is that the line of junction between any two slates or tiles shall come half over the tile below and half under the tile above. By this arrangement any water that finds its way through the joint is stopped from entering the roof on the one hand, and, coming in contact with the slate or tile

lying underneath, is compelled to trickle down it, and so from slate to slate or tile to tile in succession until it falls into the gutter below.

1208. This principle, on which all roofs consisting of overlapping pieces of material of small size must of necessity be constructed in order to be water-tight, is shown in fig. 597. In this A, A, etc., represent the laths or strips of wood that are nailed horizontally to the rafters, in order to afford a hold for the pegs or pins in the slates or tiles. A piece of boarding is usually nailed along the edge of the rafters just above the gutter in such a manner that the front of the tile that rests on it may be raised slightly above the back. Along this board a row of half-tiles is nailed, as at B, so arranged as to break joint with the tiles immediately above in the row marked C. Holes are made on either side of the tiles in the row C, just above the middle, and pegs are thrust through these holes by which the tile is hung or hitched on to the pantile lath; and this process is repeated until the top is reached, which is finished with a row of half-tiles or slates, and surmounted with a row of ridge tiles. It will be seen that all roofing made in this manner must be commenced at the bottom with the lowest course, and carried upwards until the ridge is reached. Not a peg is to be seen when the work is finished, and it can easily be imagined from this and the general arrangement, that when a tile or slate is broken it is no easy matter to remove it and insert a sound one in its place. It is often done by hanging a strip of thick zinc over the pantile lath, as at A, when the slate or tile is pushed up under those that overlap it, and its lower edge inserted into the hook formed by turning up the lower end of the strip of zinc, as shown at B, when the tile or slate presents the appearance shown at C.

Explanation of principle.

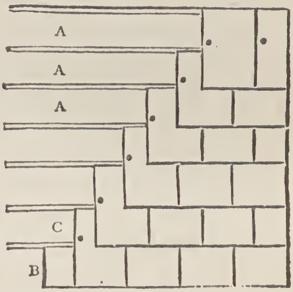


FIG. 597. ARRANGEMENT OF SLATES OR FLAT TILES.

How to replace broken slates.

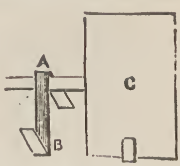


FIG. 598. SLATE HELD BY STRIP OF ZINC.

1209. No finishing with cement is necessary for tiles or slates, as the courses are held down and in place by the weight of those above them, and their peculiar overlapping arrangement, as just described, prevents the entrance of rain. Ridge tiles, however, are always set in good mortar or cement. With pantiles the

Roofing with pantiles.

case is altogether different. These are hung to the pantile laths with pegs, but from the peculiarity of their construction it is sufficient if the lower end of one course just rests on the upper edge of the course immediately below it. Pantiles, as shown in fig. 599, form a ridge and furrow surface, and the rain falls off on either side from the ridge C and D into the furrows at A and B, by which it descends to the gutter below. To keep all snug and fairly air-tight it is desirable to cement the edge of each tile where it laps over the one at its side, and where it rests on the tile beneath it. The number of tiles required to a square—that is, 10ft. each way, or 100 square feet—is as follows:

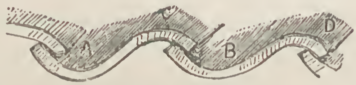


FIG. 599. PANTILES.

Number of tiles to square.

For *plain tiles*, if each tile shows on the face 4 inches, 600; if 3½ inches, 700; and if 3 inches, 800. In flat roofing 210 tiles will be required to a square.

For *pantiles*, 180 to a 10in. gauge, 164 to an 11in. gauge, and 150 to a 12in. gauge. The lap of the tile over the one below it will be just the difference between its length and the length of the gauge.

1210. All laths whether for tiles or slates must be disposed along the rafters at such distances from each other as may suit the gauge at which it has been determined to lay the tiles.

Disposition of laths.

1211. Stock and place bricks are often used for paving instead of paving-bricks, Dutch clinkers, or foot-tiles; but being not so hard as these descriptions of bricks and tiles, they are more apt to break, and will wear away the quicker. Indeed, unless the passing and repassing over them be but small, the amateur is advised never to use ordinary bricks for paving, as the friction of the feet of the passers to and fro soon wears a channel, which serves as a catch-pit for any water that may find its way into it.

Bricks used for paving.

1212. In paving it is obvious that the first thing to be done is to prepare a firm and solid bed on which the material to be used may be laid and bedded; the second thing is to see that the bed is perfectly level, if a level flooring is required, or if it is desired to slope in any particular direction, or be rounded so as to throw off the water on either side, as in the case of a paved path, to see that the bed is sloped or rounded in the manner required. Paving is generally bedded in sand, mortar, or cement, the last-named material being preferable, if durability and solidity is required. All that is now necessary is to lay the bricks or tiles in regular order, spreading

How paving is done.

a little fine cement along the edges of adjacent bricks, and of each course, that they may adhere closely together, and that no gaps or chinks be left between them. If any brick or tile happens to be a little thinner than those next to it, a little additional bedding must be laid below it to raise it to the proper level.

1213. When round stones, usually called "cobble stones," can be procured, a durable and frequently an ornamental pavement can be composed of them. They are more suitable for narrow pathways than for wide spaces. For these a well-rammed bed of earth is sufficient. They must be stood on end, being packed gradually and closely together, a piece of wood being placed across the pathway to aid in retaining them together, and moved forward when necessary. A white path may be edged with a black border or a mixed border of black and red, or lines in black or red can be produced in any direction on a white ground, as in diamonds, vandykes, etc., and other patterns which will readily suggest themselves to the ingenious amateur. When finished they should be lightly rammed or beaten to produce an equality of surface, and the interstices should be filled with sand well washed in, or with grout composed of lime, sand, and water, or a little cement instead of lime.

Paving with cobble stones.

1214. Ornamental pavements for short walks from the roadway to the front door, or a square space before the front door and similar positions, may be laid in coloured paving tiles or encaustic tiles. The coloured Staffordshire paving tiles can be had square in various sizes, and in diamonds, hexagons, and octagons. Encaustic tiles can also be had in different combinations of colour, the price varying according to combination of colour and size. The method adopted in laying them is precisely the same as that followed in laying common bricks and tiles; but greater care, of course, is necessary in doing the work, in order to arrive at a satisfactory result. A true and solid bed must first be prepared, and on this the tiles must be laid with care, fitting them closely and accurately together.

Coloured paving tiles, etc.

1215. For the prices charged by the builder, or such as are likely to be charged by the builder, the reader is referred to Laxton's or Bevis's "Price Book." If the amateur attempts to do the work himself it will cost him no more than the value of the materials used; and if he requires assistance he must add to this the amount paid for labour. As the cost of cement has been already given, all that is necessary here is to name the prices of ornamental tiles, following this with the prices of some other materials in the form of bricks, tiles, etc., which it will be useful for the amateur to know.

Estimate of cost of paving.

1216. First, the prices of encaustic tiles at the works are as below, each size being made in the combinations or single colours here given. The numbers set at the head of each column refer to these colours or combinations which are:—I. Chocolate, red, black, buff, and red. II. Red, black, buff, combinations of red, chocolate, and buff. III. White, red, buff, combinations of these colours. IV. Combinations of blue, red, buff, and white.

Cost of encaustic tiles.

Sizes.	I. s. d.	II. s. d.	III. s. d.	IV. s. d.	*Sizes.*	I. s. d.	II. s. d.	III. s. d.	IV. s. d.
$2\frac{1}{8}$in. × $2\frac{1}{8}$in. ...	0 1	0 $2\frac{1}{2}$	0 $3\frac{1}{2}$	0 4	6in. × 3in. ...	0 4	0 5	0 6	0 8
3 ,, × 3 ,, ...	0 2	0 $2\frac{3}{4}$	0 3	0 4	6 ,, × 4 ,, ..	0 5	0 7	0 9	0 11
4 ,, × 4 ,, ...	0 4	0 5	0 5	0 7	6 ,, × 6 ,, ...	0 6	0 9	0 10	1 2
$4\frac{1}{4}$,, × $4\frac{1}{4}$,, ...	0 4	0 5	0 6	0 7					

1217. The prices of the following articles are named as charged by builders when delivered on the job. It is, perhaps, preferable for the amateur to calculate the cost of his work at these prices, for it is most likely that he will be obliged to go to a local builder in order to procure them, and then, again, he will mostly require them in small quantities only, and be obliged to have them brought to him, having no means of getting them from the yard to his own place.

Builders' prices for tiles.

Tiles.	Single. s. d.	Per 100. s. d.	*Tiles.*	Single. s. d.	Per 100. s. d.
Plain $10\frac{1}{2} \times 6\frac{1}{4} \times \frac{5}{8}$	0 1	4 3	Blue roofing...	—	6 6
Pan $13\frac{1}{2} \times 9\frac{1}{2} \times \frac{1}{2}$	0 1	6 6	Blue roofing ornamental ...	—	7 0
Pan Glass	1 6	—	Ridge, *per foot*	0 $7\frac{1}{2}$	—
Paving 9in.	0 $3\frac{1}{2}$	20 6	Ridge, capped joints	1 0	—
Paving 10in.	0 4	26 0	Valley and hip	0 5	—
Paving 12in.	0 5	32 0	Channel...	0 9	—

1218. Paving tiles, other than the encaustic tiles, the prices and sizes of which have been given above, are sold per hundred at the following prices:

Prices of paving tiles.

Sizes.	*Red or Blue.* s. d.	*Buff.* s. d.	*Sizes.*	*Red or Blue.* s. d.	*Buff.* s. d.	*Sizes.*	*Red or Blue.* s. d.	*Buff.* s. d.
2in. × 2in. ...	4 6	6 6	6in. × 3in. ...	6 0	8 3	6in. hexagons	10 9	13 0
3 ,, × 3 ,, ...	5 0	7 0	6 ,, × 6 ,, ...	10 0	14 0	,, diamonds	8 0	9 0
4 ,, × 4 ,, ...	6 0	8 0	4 ,, hexagons	6 3	7 0	,, octagons	12 0	13 0

1219. Fixing coppers and ranges should be left to the professional bricklayer, as it is altogether beyond the power of the amateur to accomplish such work in a satisfactory manner. It may happen that cement or mortar may get loosened and fall away about a range or copper, and this the amateur can easily repair with a little cement and sand. He may even reset a copper if it gets loose, as it is nothing more than a circular vessel with a rounded bottom, and a flange about an inch in width at the top set in a casing of brick-work, so that the fire in the stove below may penetrate between the brick-work and the sides of the copper.

Fixing coppers and ranges.

1220. A general idea of the arrangement of a copper, and the manner in which it is set, may be gained from fig. 600, which exhibits a section of this useful adjunct to the back kitchen and even kitchen. The casing of brick-work in which the copper B is set is shown at A, A. The flange C C at the top of the copper rests on the brick-work, and the top is cemented over and sloped inwards so that any water that may escape from clothes when taken dripping out of it may run back into the copper. Below the copper is the fire-grate D from which the ashes fall into the open space E below, while the flame and heat ascend into the space F, F between the brick-work and the sides of the copper. A circular wooden cover G is generally kept over the copper, which, in nine cases out of ten, is built in an angle either in a corner of the kitchen or in one of the recesses by the kitchen or back kitchen fireplace.

How coppers are set.

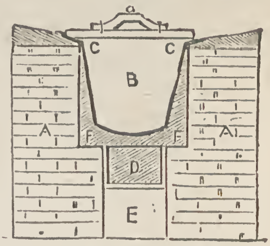


FIG. 600. ARRANGEMENT OF COPPER.

1221. It will have been noticed that the back of the register stove is sometimes made of fire-clay instead of iron. In course of time this part of the grate, of whatever material it may be made, will give way under the fierce and continuous heat to which it is subjected, and must be renewed. A new cast-iron back, or a fire tile of Welsh or Stourbridge fire-clay, may be procured from the ironmonger's, who will send a smith to fit it in.

Back of register stove.

1222. Fire tiles vary in size from 9in. to 24in., and in price from 9d. to 6s. 6d. in Welsh clay, and from 1s. to 8s. 3d. in Stourbridge clay. "Lumps," which are thicker than tiles, range in size from 12in. to 36in., and in price from 1s. to 6s. 9d. in Welsh clay, and from 2s. to 9s. 6d. in Stourbridge clay. Stourbridge fire-bricks, which are the best that are made, and which will resist the action of fire, cost about 14s. or 15s. per 100. Welsh and other descriptions of fire-bricks are cheaper. For security's sake, if the amateur is building a small fireplace in a workshop or elsewhere, he is recommended to use fire-bricks instead of ordinary stock-bricks.

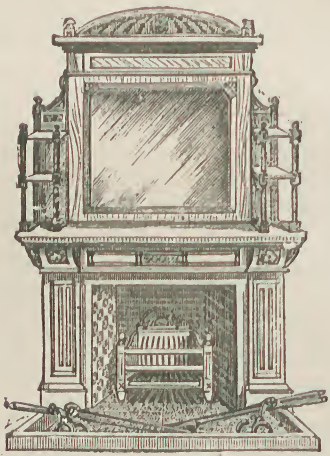
Prices of fire tiles.

1223. It may happen, however, that the amateur may wish to mend any hole that has been burnt away at the back of his grate without having recourse to the ironmonger or the smith. In this case he must procure some fire-clay from the builder's yard, or from the timber merchant, who generally keeps this material in stock, and sells it at the rate of 4s. or 5s. per cwt.

Fire clay: where to get it.

1224. Some little trouble is involved in the preparation of the clay, which must be softened and kneaded with water until it is sufficiently plastic for use. The cavity into which it is to be introduced must then be moistened with water and the clay pressed into it, especially if the bricks at the back have begun to wear away, as will sometimes happen. The front must then be finished off at the proper slope, which will be indicated by the sides or "cheeks" of the grate. The ability of fire-clay to bear a great heat without melting or vitrifying arises from the absence of any alkaline earth to act as a flux. The famous Stourbridge fire-clay contains about 64 per cent. of silica and 24 of alumina, the remaining twelve parts consisting of oxide of iron, water, and traces of carbonaceous matter.

Preparation and use of fire clay.



CHAPTER IV.

BUILDING WITHIN THE SCOPE OF AMATEURS.

Building that can be done by Amateurs—Building in Wood—Preparation of Working Drawings—Supposed Case in Brick-work—Tying New Wall to Old Wall—Knocking out Half-bricks—Plan and Elevation—Dimensions of Proposed Building—Building in Monolithic Concrete—Excavation of Trenches—Height, etc., of Building—Window in Building—Front Elevation—End Elevations—Building Walls in Concrete—Arrangement of Scaffold-boards—Formation of Doorway—Throwing in Concrete—How to save Concrete—Raising the Boards—Special Apparatus for Concrete Walls—Completion of the Walls—Window-sill—Window-frame and Wood-blocks—End of Shed on Wall—Wall-plates on top of Walls—Plan and Construction of Roof—Pisé Wall or Wall of Rammed Earth—Directions for Building Pisé Walls—Meaning of Term—Suitable kinds of Earth—Indications of suitable Earths—Preparation of Earth for Building—Soil should be Prepared Gradually—Moistening the Earth—Making the Moulds—Substructure of Earth Walls—Mode of Building Wall—Joists: their Formation—Posts: their Dimensions, etc.—The Mould-boards—Dimensions of Mould-boards — Formation of end of Wall — Way in which Wall is Built—Description of Process—Ramming the Earth—Withdrawal of Mould-boards—Filling up at End—Preparations for next layer of Earth—How to fill Joist-holes—Making Gables of House—Construction of Roof—The Rammer: its Weight, etc.—Bond Timbers in Pisé Walls—Another easy Method of Building—Lascelles' Concrete Slabs—Size, etc., of Slabs—Prices of Slabs—Good Qualities of this Material—Fish-scale Slabs—The Plain Slabs, and what may be done with them—Water-tanks—Dwarf Walls for Gardens—Concrete Studs for Copings, etc.—Steps, Pavement, etc.—The Lining Slabs—Ventilation easily Secured—The Studs: their Dimensions, etc.—Process employed in Building—Dimensions of Slabs to be taken in Account when Planning Buildings—Plan of Concrete Slab Building—The Foundation and Sills—The Uprights—Where to fix them—Uprights in Elevation—Frame-work of Building—Working Drawings must be Accurate—Front and End Elevations—Frame-work for Right End of Building—Frame-work for Left End of Building—Fitting Frame-work together — Plugging Brick Walls — Putting Frame-work in Place—Cutting and Boring Slabs — Positions occupied by Slabs — Estimate of Number Required—How Slabs are Attached to Frame-work—Fixing lowest course of Slabs—Putting remainder in Place—Fixing Rafters of Roof—Preparation of Rafters for Slabs—Laying on the Slabs—Preparation of Putty Joint—Finishing Roof with Cap—Completion of the Front—Casing for Casements—Completion of End with Doorway—Overlapping of Slabs—Other Uses for Slabs—Paving with Concrete Slabs—Construction of Tank with Slabs—Slabs as Shelves in Greenhouses, etc.—All Roofs should be Provided with Gutters—Building a Shed in Wood—Methods of Covering Wooden Frame—Weather Boarding—Distance between Uprights—Strengthening by Diagonal Braces—Vertical Boarding—How to Hide the Joints—Suitable for Roofing—Boarding

Buildings Within—Filling up between the Boards—Anglo-Danish Roofing Felt—Battens on Vertical Boarding—Chamfering Edges—Box and Cap—Dash-boards—Dash-board on Door—Wooden Gutters for Wood Building—How to Make the Gutter—Board for Bottom of Gutter—Finishing Gutter Within—Front of Gutter—Ornamentation of Front—Iron Stays—Crest-boards: how to fix them.

1225. BRICKLAYING, unless it be of the very simplest kind, involving no very great nicety in the operation, is a matter which, as it has been already said, the amateur artisan either will not care to meddle with or will most likely mismanage. Masonry, which will be noticed briefly in a future chapter, is equally difficult and dirty, although the man who aspires to be an amateur mechanic must not shrink from a little dirt. There are, however, methods of building which are more within his compass, and these may be briefly enumerated as: (1) *Building with wood.* (2) *Building with concrete.* (3) *Building with concrete slabs.*

Building that can be done by amateurs.

1226. The method of building a shed in wood, and wood only, will be found at the end of this chapter; we will commence our remarks on this part of our subject with suggestions for, and instructions on, building with concrete, made by the amateur in the manner described in a previous chapter, and building with concrete slabs.

Building in wood.

1227. The first thing to be done when any kind of building work is about to be commenced, or any constructive operation whatever involving recourse to any of the building arts or trades, is to put the work accurately on paper; that is to say, to prepare working drawings in plan, elevation, and section, according to a certain scale. By doing this, the amateur will be the better able to calculate what quantity of materials he will require; and by getting the plans that he has conceived in his mind definitely worked out on paper, he will be able to proceed all the more rapidly in the execution of the work from the commencement to the finish.

Preparation of working drawings.

1228. The only way in which any building operation can be clearly explained is to take a supposed case and to go through it in detail, and at present we will imagine that the amateur has a convenient corner in his garden, where two brick walls meet at right angles, one of which is high enough for the back of the building.

Supposed case in brick-work.

1229. Supposing that the building is to be in brick, the mode of operation can be readily gathered from what has been said in the last chapter and what will be said here about concrete buildings. A caution, however, must be given that it will be useless to build up the new brick walls without tying or bonding

Tying new wall to old wall.

them to those that are already standing. Suppose fig. 601 to represent a portion of a wall in Flemish bond, to which it is desirable to attach another at right angles, and that the dotted lines A B, C D, represent the faces, outward and inward, of a 9in. wall to be joined to it, or A B, E F, the faces of a 4½in. wall, it is manifest that, in either case, the portions of the stretchers shaded in the diagram must be knocked out to admit of the insertion of stretchers at right angles to the depth of half the length of the brick, which will tie the new wall to the old one. It *looks* easier on paper to knock out the *apparent* half-bricks in the alternate courses and throw back the wall about 2in., but this is not practicable, as these bricks are headers, going right through the wall and appearing in either face both on the outside and on the inside.

Knocking out half-bricks.

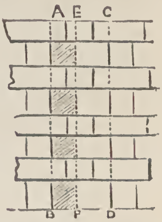


FIG. 601: TYING NEW WALL TO OLD WALL.

1230. Let us now proceed to the plan and elevation. In a one-storey building, as there is no staircase to show, a section is unnecessary; but we must have the elevation of the end that is to be built entirely, and part of the end that is to be built on the wall at right angles to the back. If we were planning a greenhouse instead of a simple shed, it would be desirable to have a section for the sake of showing shelves and staging for plants, etc., etc.

Plan and elevation.

1231. To proceed in due order, we will suppose our building to be precisely 12 ft. long and 9 ft. wide, exclusive of the brick walls against which it is to be built, and the scale on which our working drawing is made to be $\frac{3}{16}$in. to 1ft. The walls are to be 9in. walls, and the opening for the doorway which is to be at the end that we have to build, is to be 2ft. 9in. wide. The brick walls are also 9in. walls. Space obliges us to take so small a scale for our

Dimensions of proposed building.

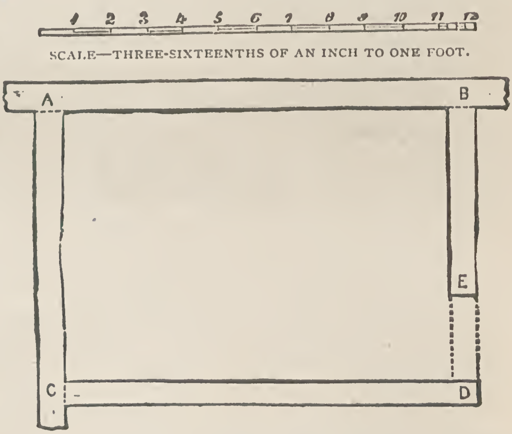


FIG. 602. PLAN OF SHED.

working drawings, but in practice the amateur will find it desirable to take from ½in. to 1in. to a foot for his scale. From the data already given we have enough to proceed to the construction of our plan, and here it is in fig. 602, constructed on the scale appended, namely, that of $\frac{3}{16}$in. to 1ft. The walls A B and A C are the old walls, and C D and B E the new ones, or those which have yet to be built. The opening for the doorway D E is 2ft. 9in. wide, and the walls are 9in. thick.

Building in monolithic concrete.

1232. We will consider, first of all, that it is intended to build the walls in "monolithic" concrete, that is to say, a wall composed of concrete built up piece-meal which hardens into a solid unbroken mass. Now A B and A C are brick walls, but it is no less desirable that the new concrete walls should be bonded or tied to these even though the materials are different, so we proceed to knock out the stretchers or half-stretchers at B and C, as may be most practicable and convenient. Meanwhile trenches have been excavated from C to D, and from D to B, of the necessary width; that is to say, 9in., for the trench need not be larger for concrete foundations, and the earth at the bottom of the trenches has been rendered solid by ramming the mould well together. It will be useful now to have the front elevation and the end elevations, and in order to draw these with accuracy, we must determine the height of the building in front and rear. The wall that forms the back of the building is 10ft. high, and that of the side wall is only 6ft., but we wish the front of the building to be 8ft. high. This will give but little slope to the roof, but it is sufficient for the purpose, as the area of the roof will be but a little larger than the ground on which the building stands.

Excavation of trenches.

Height, etc., of building.

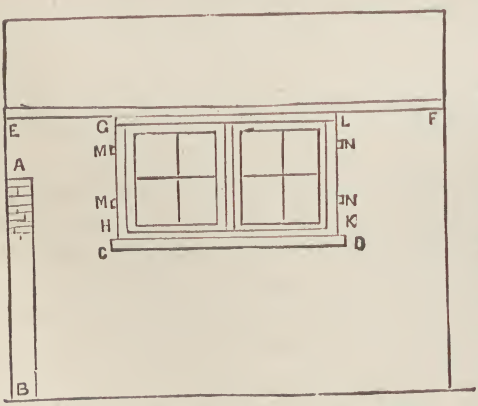


FIG. 603. FRONT ELEVATION FOR SHED.

1233. Now supposing in addition to the dimensions already given we have determined to have a window in the front elevation, 6ft. wide and 4ft. high, or one for which we must leave an opening of these dimensions, the front elevation of the shed

Window in building.

will, when drawn, assume the appearance shown in fig. 603, A B being the section of the brick side-wall which serves as part of the left-hand end wall of the shed. The construction of the window and of the roof as well will be explained presently, but for the present we have only to think of the walls or carcass of the structure, leaving the fittings, etc., for further consideration. It must be remembered that the amateur is in no way bound to follow the dimensions here given ; he will find that he must of necessity adapt his building to contingent circumstance ; the dimensions here given are, for many reasons, very convenient.

Front elevation.

1234. Before we can begin our walls, however, we must get out our end elevations, and, for convenience' sake, we will put them together as if they had been opened out level with the front being attached to it by hinges, the front being supposed to occupy the space that intervenes between fig. 604 and fig. 605. In

End elevations.

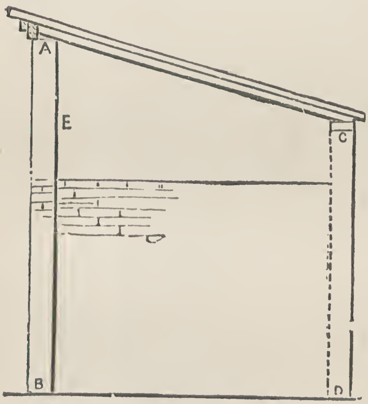


FIG. 604. LEFT-HAND ELEVATION OF SHED.

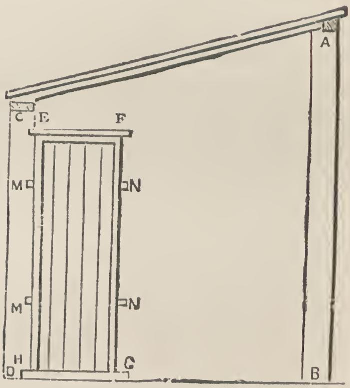


FIG. 605. RIGHT-HAND ELEVATION OF SHED.

both these figures, A B represents the section of the brick wall that forms the back of the shed, and C D the end of the front wall ; the latter being shown by dotted lines. A C in each case represents the end rafter ; the rafter being laid at intervals, as will be explained presently, to support the material, be it what it may, that is used for roofing. The door is shown at E F G H, in fig. 605, as the window is shown in the front elevation, but neither of these need be described at present.

1235. We can now begin to build our walls ; the trenches having been opened and filled with concrete to the level of the ground, and a

stout door-sill of oak, about 3in. thick, bedded on the concrete just

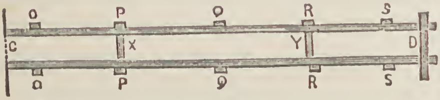


FIG. 606. ARRANGEMENT OF SCAFFOLD-BOARDS.

Building walls in concrete.

on or above the ground level as shown at H G, in fig. 605. First some scaffold-boards and stout stakes are procured, and the stakes are driven into the ground on each side of the space on which the wall C D is to be raised, as shown at O, P, Q, R, S, in fig. 606. Within these stakes, scaffold-boards placed on edge are arranged, the stakes being driven in at such a distance apart that the space between the scaffold-boards may be a little over 9in., the required width of the wall, to allow for shrinkage. A short piece of board is put across the other boards to form the end of the wall at D, or, as the wall at ~~the side~~ will be built at the same time, it will be better to set boards right across from D to B in fig. 602, forming the doorway by placing stops across between the scaffold-boards, as at X, Y, in fig. 606, which must be introduced when the wall has been raised to the height of 4ft., and it is necessary to form the window opening.

Arrangement of scaffold-boards.

Formation of doorway.

1236. The boards being set in place—say two boards on either side, which will give a height of 22in.—and a quantity of concrete ready mixed, the concrete is thrown down with some force into the space between the boards in order to consolidate it, and let it settle well together. To save concrete and eke out the materials, any rough stuff such as brick-bats, stones, flints, etc., may be placed in the middle of the wall, due care being taken that they do not come in contact with the boards on either side, and so appear in the surface of the wall. When the space between the boards has been filled up, the mass must be left for two or three days to harden. It will then be found that the concrete has shrunk in settling, and does not come to the edge of the topmost board. The lower part of the wall being hard enough, the lower board may be withdrawn and placed on the top of the upper one, and the filling-in process repeated. The withdrawal of the lower board and the placing it above the upper board must be continued until the wall has been raised to the required height.

Throwing in concrete.

How to save concrete.

Raising the boards.

1237. Special apparatus have been devised for building concrete walls of this kind, and for connecting them at right angles, either at the corners of a building, or where one wall is run out from the middle of another, but these are most expensive either to buy or to

borrow. All the amateur wants are the simple appliances already described. His stakes should be square and strong, and the opposite pairs should be connected with bolts or braces, so as to keep them equi-distant during the construction of the wall; these, of course, can be removed when they interfere with the progress of the work. It is as well, too, to fasten the stakes to the scaffold-boards by long screws, say of 5in. or 6in. in length, which can be withdrawn when the board must be removed. One of the chief objects in rising the screws is to prevent any chance of the upper board slipping, when the board below it is withdrawn.

Special apparatus for concrete walls.

1238. After the explanation of the process above given has been thoroughly mastered, the amateur will find no difficulty in building any concrete wall of moderate height in this way. It is necessary, however, now to turn our attention to the completion of the walls, first in front, and then on either side.

Completion of the walls.

1239. And first with regard to the front. When this has been raised to the height of 4ft., a stout window-sill should be placed in position at C D (fig. 603). This should be 6ft. 6in. long at the least, so as to extend 3in. on either side beyond the frame of the window; and it should be 11in. or 12in. wide, so as to be even with the inner face of the wall and project 2in. or 3in. beyond the outer faces. The wall should then be raised very nearly to its full height, when a wall-plate, at least 2in. thick and 4in. wide, should be laid from end to end of the wall, the outer part being even with the outer face of the wall. The window-sill C D below and the wall-plate E F above will thus form convenient parts to which to nail the frame in which the casement windows are to be hung. This frame is represented by G H K L. When the wall is building it will be useful to introduce pieces of timber as long as the wall is thick, and about 3in. square, as at M, M, and N, N, to form additional points of attachment to which to nail the window-frame.

Window-sill.

Window-frame and wood blocks.

1240. The end of the shed to the left hand, as shown in fig. 604, must be raised on the brick-work in the same manner as the other walls, care being taken to remove half-bricks, so that the side E may be bonded completely to the wall A B. In building the end of the shed to the right hand, as shown in fig 605, equal care must be taken to tie the end to the wall at the back, as shown in section at A B. A strong lintel must be inserted at E F, when the opening for the doorway is high enough, and, as with the window, bond timbers should be inserted in the reveals of the doorway at M M and N N, to which the frame may be nailed.

End of shed on wall.

1241. When all this has been done, it will be desirable to lay a wall-plate along the top and the back wall, and on the side walls as well. These wall-plates should be about 3in. thick—certainly not less than 2in.—and the side rafters should be cut so that the upper surface may be coincident with that of the inner edge of the wall-plate on the back wall, running away to nothing on the front wall-plate as shown in fig. 604 and fig. 605. All the wall-plates should be bedded in the concrete, and the spaces between the rafters when laid filled up with the same materials. Rafters about 2in. thick and 3in. deep may now be laid to form supports for the roof, one end resting on the wall-plate on the back wall, and the other end on the wall-plate on the front wall, as shown in fig. 607. The wall-plates on the end walls will appear as in the dotted lines in this figure, and on the top of each of these must be laid a strip of wood to bring it level with the top of the other rafters; unless, indeed, and which would do quite as well, wall-plate and rafter at the end were combined in one piece, and notched on to the upper and lower wall-plates in such a manner as to bring them level with the rest of the rafters.

Wall-plates on top of walls.

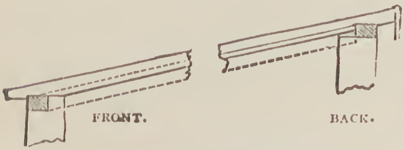


FIG. 607. ARRANGEMENT OF RAFTERS.

1242. The plan of the roof will appear as shown in fig. 608, in which the pieces A, A, are the seven rafters, 2ft. apart resting one end on the wall-plate B B on the back wall, and the other end on the wall-plate C C on the front wall. We are here more particularly concerned with the mode of building walls, but the method of covering in the roof will be given in detail in a future chapter. There are various modes of forming a roof, and different materials, such as wood, slates, and tiles, with which the roof can be covered, as the reader well knows.

Plan and construction of roof.

FIG. 608. PLAN OF ROOF.

The making of the door and window, as well as the construction of the roof, belong strictly to carpentry and joinery. The necessary mode of procedure in preparing and fixing the rafters has just been given: instructions for making doors and windows will be found in Chapter VII. of Part II. of this work.

1243. If the amateur cannot get lime and gravel or stones for making concrete he may yet manage to make a wall very similar in character, namely, the pisé wall, or wall of hard-rammed earth, known in Devonshire and Somersetshire as a "cob" wall. Moulds of board should be made and fixed in the same manner as for concrete walls, and suitable earth for the purpose having been obtained, this is used either by itself, or mixed with chopped straw, and, when put in the mould, rammed hard with a rammer, and left to harden. Houses made of these clay walls are durable, warm, and dry.

Pisé wall or wall of rammed earth.

1244. The following directions with regard to the kinds of earth best suited for walls of this description, and the manner in which the earth is to be prepared before it is used, are taken from Burn's "Handbook of the Mechanical Arts."

Directions for building pisé walls.

1245. "The term 'pisé' is derived from the name of the instrument with which the earth is rammed down, *pisoir*. The kind of earth or soil best adapted for pisé is that known as gravelly. By this term is meant a soil in which the pebbles are round, not flat or angular. It is evident that in ramming the soil, the packing will be equally round the circular pebbles, while the flat or angular ones may resist the stroke of the rammer and ward off in a measure the force of the stroke from some portion of the soil beneath them. Brick earths are well adapted for pisé, but owing to the capacity for retaining moisture, they are apt to crack, unless carefully shielded from the wet, during the process of drying the walls. All kinds of earth, however, may be used, with the exception of light, poor lands, and strong clays; these, however, will do if judiciously mixed with other better fitted soil. To show how this mixing may be most successfully carried out, a few sentences may be useful: the principle of mixing is simply to blend a light earth with a strong, a clayey with a sandy or gravelly kind. Where the best kind of soil—that is, gravelly—cannot be obtained, small round pebbles, etc., may be mixed with it. All animal or vegetable substances that are apt soon to decay must be carefully kept out of the soil to be used. The following indications, which may be observed in order to judge of the fitness of the soil for pisé

Meaning of term.

Suitable kinds of earth.

Indications of suitable earths.

in any district, may be useful. In digging, if the spade brings up large lumps at a time, the soil is well adapted for the work; this holds also where the soil lies on arable land in large clods, and binds after a heavy shower and a hot sun. Where vermin holes are smooth in the inside and firm, or where the small lumps generally found in plenty in all fields are difficult to be crumbled between the fingers, the soil is good. Soil of good quality is generally found at the bottom of slopes that are in cultivation, and on the banks of rivers.

1246. "In preparing the earth for building, the first operation is breaking the clods or lumps, and thereafter placing the soil in a conical heap; this form facilitates the removal of large, flat, and circular stones, which, falling to the bottom, are easily removed from the mass by means of a rake. The teeth of the rake should be placed at intervals of 1in. or thereabouts, so that only stones exceeding this in size may be withdrawn; or, what would be better and quicker, a bricklayer's sieve or 'screen' might be used, having the meshes about an inch square. Where two varieties of soil are to be mixed, the operation should be done at this stage. Enough of soil should only be prepared to last a day's working. Care must be taken to prevent rain saturating the earth with water, as in this state it will form mere mud in the mould. It is necessary to note that the soil is in the best condition for working when neither too dry nor too wet. It is very evident that less time will be lost in slightly wetting the soil when too dry, than in waiting for it to dry should it get saturated with rain by a careless exposure."

Preparation of earth for building.

Soil should be prepared gradually.

1247. To the foregoing remarks it is only requisite to add that when it is found necessary to moisten the earth, the water should be sprinkled over it through the fine rose of a water-pot, and not slashed over the soil from a pail or bucket. Nothing is said about the admixture of straw, but the addition of this is useful, as when cut in short lengths—say from 3in. to 6in. long—and mixed with the earth, it serves to bind it together, just as lengths of hoop-iron add to the strength of brick-work.

Moistening the earth.

1248. It is now necessary to describe the manner in which the moulds are made, and how they are to be used in making the wall, and this necessary information has been gathered from the "Handbook of the Mechanical Arts." It will be noticed that the mode of operation pursued is akin to that adopted for making concrete walls, though the former differs from the latter in many essential particulars.

Making the moulds.

1249. Firstly, it is manifest that it will not do to put an earth wall in immediate contact with the ground. This must in all cases be avoided, and foundations should be laid in brick, stone, or concrete, the wall, whatever may be the material of which it is made, being carried from 1ft. to 3ft. above the surface of the ground, or even more, if it be found convenient to do so. In Devonshire, where "cob" walls were once much used for barns, stables, linhays, and even for the cottages of the poor, the lower course of stone walling was generally as much as 5ft. above the ground-level. While speaking of the cob wall it may be as well to say that an old wall of this kind, when pulled down and reduced to small pieces or even to dust, affords an excellent manure for grass lands.

Substructure of earth walls.

1250. The plan to be adopted in building pisé walls will be best understood from a careful inspection of fig. 609, in which the construction of the necessary apparatus or mould for the wall is clearly shown. Beginning at the bottom, let us suppose that A represents the foundation wall in section, this wall being 1½ bricks thick, or, in even figures, 14in. from face to face. In building this wall cross-pieces of timber, F G, must be laid on the top, when it has reached the height B C, and the spaces between these pieces filled in with walling until it is level with their upper surface. The top of the wall thus presents a continuous surface from end to end, broken only by the "joists," as these cross-pieces are technically called. The joists should be of hard timber, 4½in. broad, and 2½in. thick, that is to say, of the breadth and thickness of a brick. They should taper a little, that is to say, be about ½in. less in breadth at one end than they are at the other, so that they may be easily knocked out of the wall when it is necessary to remove them. Grooves about 1in. wide, and the same in depth, should be cut *across* the joists at J and H, in

Mode of building wall.

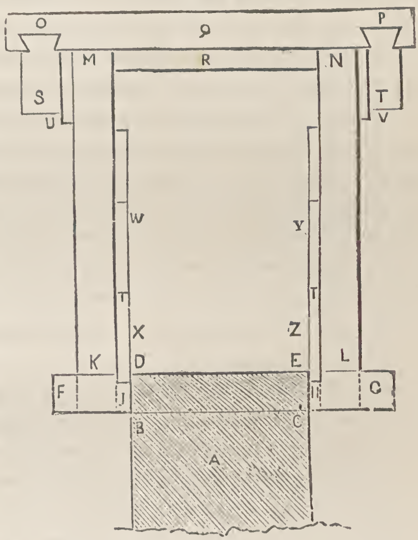


Fig. 609. Apparatus for building earth wall.

Joists: their formation.

order to receive the boards which form the "mould," and mortises must be made at K and L, as shown by the dotted lines, to receive the tenons cut at the ends K, L, of the posts K M, L N. These posts should be of the same dimensions as the joists, as regards breadth and thickness, and from 18in. to 2ft. in length. It is necessary to provide some contrivance for keeping the posts the same distance apart at the top as they are at the bottom, and this is done by means of cross-pieces, as shown at Q.

Posts: their dimensions, etc.

1251. As the breadth of the wall is 14in., and the thickness of the mould-boards shown at W, X, Y, Z, is 1in., a cleat R, 16in. long, must be nailed to the lower face of the cap Q, into which short pieces of the same breadth and thickness, shown at S and T, have been attached at right angles by means of the dovetail joints, O and P. Between these pieces and the heads M and N of the posts K M, L N, wedges U, V, are driven, in order to press these ends tightly against the ends of the cleat R. Frames of this kind, precisely similar to each other, must be placed at distances varying from 18in. to 2ft. along the wall, and within them the mould-boards are placed, between which the earth will be thrown and rammed. These mould-boards should be of good pine wood, not less than 1in. in thickness; they should be dowelled or pegged together, and otherwise secured by battens screwed on to them at short intervals along their length transversely to the grain. From 6ft. to 12ft. will be found a convenient length for the mould-boards, and it is as well to have three or four pairs of mould boards of different lengths.

The mould-boards.

Dimensions of mould-boards.

1252. To form the end of a pisé wall battens *a*, *a*, about 2in. or 3in. wide and 1in. thick, must be nailed to the *inside* of the mould-boards W, X, and Y, Z, at one end, which must of course be the end where the wall is to terminate or be turned at an angle, and a piece of wood *b*, fitted against the battens. The method by which this is done is shown in fig. 610, which represents the arrangement of mould-boards, end-boards, and battens in elevation; and fig. 611, which represents the same in section. When an angle has to be made, a special moulding may be made for the purpose, or the ordinary mould-boards may be arranged by means of battens as shown in fig. 610 and fig. 611. The amateur who thoroughly comprehends the

Formation of end of wall.

FIG. 610. ELEVATION.

FIG. 611. SECTION APPARATUS FOR END OF WALL.

description that has been given as far as it goes will have no difficulty in turning it to account in making an angle, or, in other words, the corner of a building.

1253. The frames and mould-boards being in position and the earth all ready, the next thing to be done is to make the wall by filling in the earth and ramming it well together, and for a description of the manner in which this is to be done, we cannot do better than quote Mr. Burn's clear and ample directions.

Way in which wall is built.

1254. "Before commencing to ram the earth in the mould, it will be necessary to try it by means of the plumb-line and square, to ascertain that it is properly levelled. The operation must be commenced at one angle of the wall, the head of the mould being at the outer extremity of the wall, within 14in. of it, the joints being at that distance from the outer extremity, in consequence of the thickness of the return wall. The labourers appointed to prepare the mould hand it up to those engaged in ramming it; these take the earth and lay it out at the bottom of the mould to the depth of 3in. or 4in., more than this depth should not be put in at one time. The first strokes of the rammer should be made close to the edges of the mould, thereafter going over the whole surface in regular succession, from the head of the mould downwards, thereafter crossing these first blows or indents by another succession. Care should be taken to give to each layer as equal a compactness as possible, which is easily attainable; the parts under the caps must be carefully looked to, as from their position the rammer must be used obliquely."

Description of process.

Ramming the earth.

1255. The mould being thus filled by successive layers, each equally well rammed, the wedges holding the caps must be withdrawn, the caps taken off, the sides thus released, taken out, and the joists finally drawn out of their holes in the wall, which should be filled up by proper means. In filling up the mould, the inner end should not be filled up to the same height as the other parts, but should be made to slope down gradually. This is shown in fig. 612, at A A. Supposing B B to represent the foundation walling, and A A the first course of earth laid and rammed upon it; if the wall be longer than the longest set of moulds, the joists at C, C must be removed and inserted in the

Withdrawal of mould-boards.

Filling up at end.

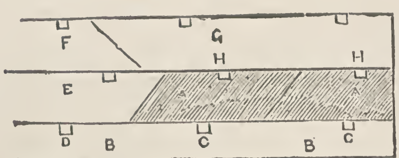


FIG. 612. METHOD OF FILLING MOULD.

foundation again further on as at D, and as soon as the entire framing has been removed from A A, and again erected, the second length of earth wall as at E must be erected. "The foundation wall being, by a succession of moulds, covered with a wall of rammed earth, the height being equal to the depth of the mould, holes or slits are cut in the upper surface in which to lay the joists (as at H, H). These being prepared, the mould is to be set up as before at an angle of the wall, the sides having the battens at one end, against which to fix the end; but the operation is to be begun at the opposite end of the wall to that originally started with. By this means, as each end of the mould is left sloping off as before, the sloped surfaces in the second course will lie the contrary way to those in the first: the bond between the several courses will thus be increased in efficiency. It should be borne in mind that the holes for the joists cut in the upper surfaces of the successive layers should be so placed as not to be exactly above one another in all the courses, but each succeeding series between those of the series below." These recommendations will be seen exemplified in fig. 612. The holes left by the joists may be filled up with a cement formed of one part cement, two parts sand, one part earth, after the completion of the wall.

Preparations for next layer of earth.

How to fill joist holes.

1256. "The gables of a house can easily be made, by making the successive layers each shorter than the one immediately below it, the requisite slope will thus be obtained. When a day's work is finished the wall should be covered with boarding, so that it may be protected in event of rain, and the roof should be put on as soon after the walls are completed as possible. The roof should overhang at least 12in., to protect the vertical walls from the effect of rain. Where the building consists of two stories, the walls of the upper story may be made thinner than the lower, by setting at the level of the first floor a depth of two or more inches from the inside, the outside being flush with the outside of the lower wall. The rammer may be made of hard wood or cast iron; if of the latter material its weight may be 14lbs., or thereabouts.

Making gables of house.

Construction of roof.

The rammer: its weight, etc.

1257. "Bond timbers may be used with advantage in pisé walls; they should be of the length of the mould, and in breadth equal to one-third the thickness of the wall. As they are completely imbedded in the earth, they last for a great length of time. If considered necessary or more economical, the inside faces of the bond timbers may be made to lie flush with the inside

Bond timbers in pisé walls.

wall of the house. In this case they will serve as battens in which to drive nails or holdfasts, for many convenient purposes. The openings for doors and windows should be left a little less than required. They may be dressed after the building is finished to the proper dimensions. Wood bricks should be built in here and there, to which to fasten the dressings and frames. The openings are made by placing heads, or a head, in the mould at the place where the wall is to terminate and the opening begin."

Another easy method of building.

1258. Two simple and comparatively easy methods of building have now been described, but there is a third way, which is even easier and simpler, and which is earnestly recommended to the attention of the amateur. Building by the means about to be noticed does not involve the dirt and mess that is inseparable from building in concrete and pisé, where the material must be used wet in one case, and damp, to say the least of it, in the other. It does not involve the delay that must necessarily occur in building concrete and cob walls, by waiting to let one course settle and solidify before the next course is put on, and therefore can be done much more rapidly; and lastly, it furnishes a strong and durable wall, completely impervious to water, that does not occupy a fourth of the space taken up by an ordinary 9in. wall.

Lascelles' concrete slabs.

1259. The new building material to which reference is made is the Patent Concrete Slab, introduced about the year 1875 by MR. W. H. LASCELLES, *Builder*, 121, *Bunhill Row, London, E.C.*, who will answer any inquiries that amateurs may wish to make respecting the slabs themselves, and the easiest mode of obtaining them. Fig. 613 will show the general character of the Fish-scale Tile Slab, which is the best and most ornamental kind that Lascelles supplies. All the slabs, whether fish-scale, plain, or lining, are of uniform size, namely, 3ft. by 2ft.; they are 1½in. thick, with the exception of the lining slab, which is only 1in. thick.

Size, etc., of slabs.

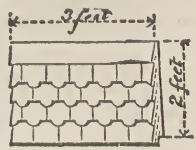


FIG. 613. LASCELLES' FISH-SCALE TILE SLAB.

Prices of slabs.

1260. The prices of Lascelles' patent concrete slabs are as follows: —Fish-scale tile slabs, £12 10s. per 100, or 2s. 6d. each, being equal to 5d. per foot super. These slabs are faced on one side and coloured red, and furnished with a rabbet or rebate at the bottom of the slab, which fits over the thinner upper edge of the slab next below it. The plain slabs, of a uniform thickness throughout, are also faced on one side, but they are grey in

colour; these are £10 per 100, or 2s. each, being equal to 4d. per foot super. The lining slabs used for the interior of buildings are faced with cement on one side like the others, and cost £8 15s. per 100, or 1s. 9d. each, equal to 3½d. per foot super.

1261. The patent material, being cast, is perfectly true on the surface, and will make perfectly level and good work; it sets as hard as stone, and will wear equal to any tiling. The extreme hardness enables the patentee to send it securely packed any distance by rail without fear of damage. It is quite fire-proof and water-proof, and can be cut with a cold chisel. The slabs, indeed, may be cut with an axe or old saw, and they can be bored through easily with a brace and bit if the surface is first broken with a punch. The fish-scale slabs, as it has been said, are notched or rebated on the lower edge, so as to form a weather-proof joint, and are intended for outside work, such as outer walls and roofs; they can be used for covering dilapidations or unsightly work in old houses, on new walls for appearance' sake, and to keep out the weather.

Good qualities of this material.

Fish-scale slabs.

1262. The plain slabs have one face smooth, and the other slightly rough; they are used for party-walls, ground-floors, etc., and they can be secured to the lower edge of joists to form fire-proof ceilings, or on the upper edge of joists to form floors, in which case no ceiling is required. If the rough face is put upwards, it can be set in cement and sand, or lime and sand, and a good even face produced. They can be finished outside to represent red or buff brick-work when used for outer walls, and they can also be rough-cast or harled to form a representation of half-timbered work.

The plain slabs, and what may be done with them.

1263. Tanks that will hold water can be formed by screwing them together as if they were wood; but if the tanks are sunk in the ground, the edges can be cemented instead, the inside to be finished in net cement. Good garden paths are formed by laying them on the ground as paving stones. Dwarf garden or other walls can be formed by building them with cement, edge to edge, with a coping on the top formed by a stud of the same material. These studs are faced on three sides; they are 8ft. long, 4in. wide, and 4in. thick, and cost £11 15s. per 100, or 2s. 4d. each, a price equivalent to 3½d. per foot run. A similar stud should be bedded in the ground to form a sill for the wall; and for walls more than one slab in height, an upright stud for screwing to will be required. The wall

Water tanks.

Dwarf walls for gardens.

Concrete studs for coping, etc.

can be finished in cement and sand to match red brick-work, or merely whitened or coloured. The slabs make excellent steps for garden or warehouse purposes; and they are useful for other purposes, such as shelves for wine-cellars, larders, conservatories, greenhouses, etc. Not the least merit attached to them is that they can be taken down and used again for any purpose that may be required.

Steps, pavement, etc.

1264. The lining slabs, which are only 1in. thick, can be used for any of the purposes enumerated above, but are mostly intended for the better class of buildings, where the appearance of an inside stud would be objected to, as by screwing them on in the room so as to form, as it were, an inner skin, the effect of an ordinary wall is produced, which can be painted, coloured, or papered. By the use of lining slabs for the purpose for which they were originally intended, a better wall is formed, by which the penetration of wind and wet into the house is entirely prevented, and an excellent opportunity is obtained for ventilating the house by utilizing the hollow spaces as air-shafts.

The lining slabs.

Ventilation easily secured.

1265. The studs are blocks of cement of the dimensions given, having an iron rod through the centre: they have three smooth faces, and one rough face, as it has been said, with a small moulding on two edges. They are used for ground floor-joists, to which the floor-slabs can be screwed; sill pieces or foundation blocks, which can be put two or three deep if required; upright studs to stand on foundation blocks; head pieces to connect them together; window frames and door frames. These are the ordinary purposes to which these studs can be applied; but for general building purposes, wood will be found much handier and cheaper and very durable. It is in extremely damp situations and where a fire-proof structure is necessary that the studs will be found most useful.

The studs: their dimensions, etc.

1266. Let us now examine the process employed in building a house of these concrete slabs; and for convenience' sake, let us take the same kind of house represented in plan, elevation, etc., in fig. 602, and subsequent figures, and see how this structure may be built up with concrete slabs, instead of concrete used on the monolithic system as then described.

Process employed in building.

1267. It is important to remember that the slabs measure 3ft. by 2ft. It is necessary, therefore, that any building that is made of them should have its length and breadth multiples of 3, and its height a multiple of 2; or in other words, that its length and breadth shall be of such dimensions as may be divided by 3 without a remainder, and its height such

Dimensions of slabs to be taken in account when planning buildings.

that it may be divided by 2 without a remainder. There will then be no necessity either to cut any slabs, or to put up any studs at closer intervals to which the slabs thus cut may be screwed.

1268. The structure now under consideration is to be built in a corner formed by two brick walls at right angles to each other: it is to be 12ft. long, 9ft. wide, and 8ft. high in front and 10ft. high behind, with a roof sloping to the front. First of all, the trenches B D and C D must be excavated and filled in with cement, but instead of making the foundation 9in. wide, as in the former case, it may be as well to let it be 12in. wide, as shown by the dotted lines in the figure. This concrete foundation must be smoothed and duly levelled to form a bed for the wooden sills B D, C D, which are laid on it. These sills should not be less than 4in. wide and 3in. thick.

Plan of concrete slab building.

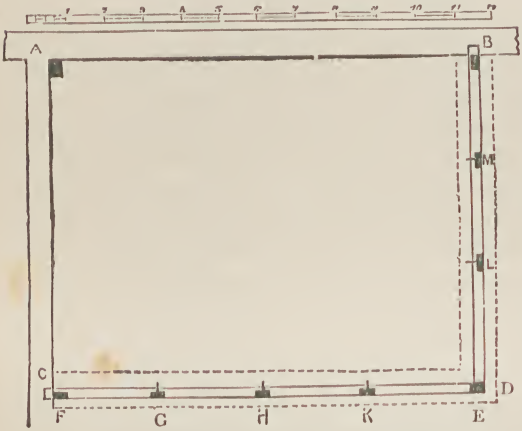


FIG. 614. PLAN OF CONCRETE SLAB BUILDING.

The sill C D must be 12ft. long, and the sill B D 8ft. 8in. long, which, with the breadth of the sill C D, which is 4in., makes the distance from the wall at B, to the outer face of the sill C D, exactly 9ft. Now as 12 and 9 are multiples of 3, or divisible by 3 without a remainder, the length and breadth of the proposed structure will exactly suit the dimensions of the studs.

The foundation and sills.

1269. Now in the sills B D and C D mortises must be cut to receive the tenons of uprights which are intended as supports for the slabs, and these studs may be, for the sake of strength and solidity, 4in. wide and 3in. thick. To determine exactly where these studs are to be fixed in the sills, divide B E into three equal parts, and C D into four equal parts. Five studs will be wanted in C D and three in B E; and these studs are to be placed at F, G, H, K, E, and L, M, B, as indicated by the black marks. The entire plan of the building is exhibited in fig. 614. It will be necessary to explain that the sills should be cut about 2in. longer than

The uprights.

Where to fix them.

the lengths named, that is, 12ft. 2in. and 8ft. 10in., instead of 12ft. and 8ft. 8in., in order that holes may be cut in the brick-work, and the extra length introduced into the holes in order to give the sills a holding in the walls A B, A C. The opening for the door may be as before, between D and L, and for the window between G and K.

1270. As far as we have gone we have dealt with the uprights and sill in which the uprights are mortised in the plan only: it will now be necessary to explain how they will appear in the elevation, and to show what further must be done to form a strong and substantial skeleton of wood, as it were, to which the slabs may be fixed. The skeleton or framework of the building must of necessity be put together in a workman-like manner before a single slab is attached to it. Every point must be looked at and considered, so that nothing that is necessary may be over-looked; for it is no easy matter to put in any timber that has been omitted after the work has been fitted together and fastened by nails and pins.

Uprights in elevation.

Framework of building.

1271. And in this lies the value of making working drawings accurately and to scale of any building and its various parts before the work is actually commenced. "Well begun is half done," is in no case more true than in work of this kind; for when the working drawing has been completed, and the amateur has every part of the building he is about to erect carefully worked out on paper, he will find it will not take him half so long to get through it as it would if he had entered on his task in a desultory, undetermined manner.

Working drawings must be accurate.

1272. We will first deal with the front and end elevation to the right hand, in which is the doorway. The sills C D, B D, it will be remembered, are 3in. thick, the former being 12ft. long from end to end and the latter 8ft. 8in., making with the *breadth* of the sill CD just 9ft. from the wall to the front of the timbers. To make the frame-work of the front, another piece similar to C D will be necessary, of the same length and 3in. square. This will form the top of the frame-work, as A B in fig. 615. Five uprights must now be cut,

Front and end elevations.

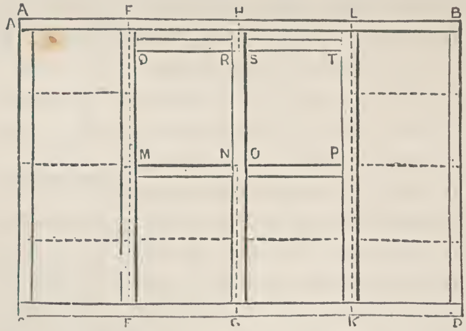


FIG. 615. FRONT OF CONCRETE SLAB BUILDING.

measuring 8ft. long, and these must be let into the horizontal pieces A B, C D with 3in. tenons, which will bring the dimensions of the frame-work for the front to 12ft. × 8ft. exactly. These uprights, when placed in the position they are to occupy, are shown in fig. 615, by C A, E F, G H, K L, and D B. They are, as before stated, 4in. wide and 3in. thick; the breadth facing outwards and inwards. Into the uprights E F, G H, and G H, K L must be mortised two cross-pieces of wood 3ft. long and 3in. square, in such a manner that the distance between the *top* of M N and O P and the *bottom* of the sill is exactly 4ft., and the space between the top of A B and the bottom of Q R and S T either 9in. or 12in.—as may be thought best.

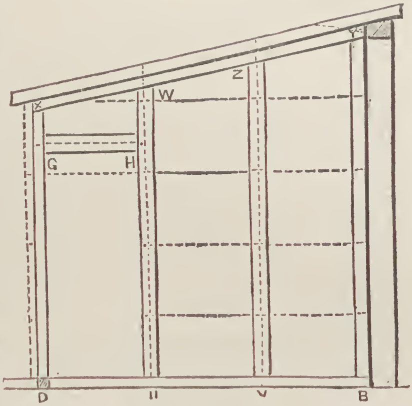


FIG. 616. RIGHT END OF CONCRETE SLAB BUILDING.

1273. For the frame-work at the end of the building to the right hand, shown in fig. 616, a piece, X Y, must be cut a trifle over 9ft. in length and 3in. square, to receive the upper ends of the uprights B Y, V Z, U W. The *side* of the upright B D in fig. 615 forms the upright D X in fig. 616. Between the uprights D X and U W a cross-piece, G H, must be framed in; this piece may be 4in. wide and 3in. thick, and should be put in so that the length between the *top* of the cross-piece and the bottom of the sill shall be precisely 7ft. This is done in order to give good headway for the door, and to admit of the opening above being filled up by a single slab. The end D of the sill B D, and the end X of the slanting piece Y X, should be dovetailed into the pieces C D and A B respectively in fig. 615, so as to tie the front and end together at top and bottom.

Frame-work for right end of building.

1274. We must now turn our attention to the frame-work required for the end to the left hand. This end is partly made up of the 6ft. brick wall, and the opening between this and the roof of the shed must be filled up with slabs. To do this a frame-work, such as is shown in fig. 617, will be required. A piece, A B, will be wanted for the sill, to support which some concrete should be laid at the foot of the brick wall on the side that faces inwards

Frame-work for left end of building.

to the shed. Uprights A C, B D must be fitted into the sill and into a slanting piece C D, as in the opposite end, and a long timber E F between the uprights. This timber may be 4in. wide and 3in. thick, and inserted into the uprights at such a height that its face may be 2in. below and 2in. above the top of the wall shown by the dotted line G H. Between this horizontal timber and the slanting piece C D, short uprights K L, M N must be fitted.

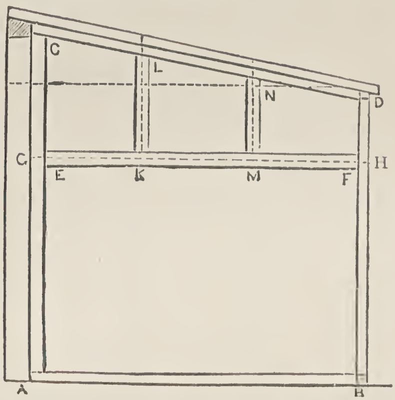


FIG. 617. LEFT END OF CONCRETE SLAB BUILDING.

1275. It must be borne in mind that none of the parts of the frame-work must be fastened together until the whole is ready. When this has been effected the first step will be to get the sills laid in position on the concrete, and secured at the corners. Then the uprights against the wall at the back should be fitted into their places in the sills and nailed to the wall, due provision having been made for this by "plugging" the wall, that is to say, driving pieces of wood between the bricks at certain intervals to afford holding for the nails which are driven through the uprights, and thence into the plugs. And here it may be convenient to say a few words about the proper manner of making or cutting a plug to drive between bricks. Suppose fig. 618 to represent a rectangular piece of wood about 4in. long, 3in. wide, and from ¾in. to 1in. thick; cut away with a chisel the opposite corners A and B so that in their place two triangular faces, C D E, F G H, may be obtained. In driving into the brick-work the corners E and H are so tightly locked or dovetailed into the bricks that it is well-nigh impossible to get the plug out without splitting it to pieces, and, of course, the more it is driven the tighter it will be fixed. As soon as the top of the plug gets bruised by the blows it should be driven no further, lest it be split and so rendered less useful; the projecting end must then be cut off with a saw.

Fitting frame-work together.

Plugging brick walls.

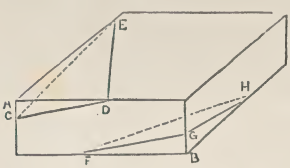


FIG. 618. WOODEN PLUG FOR BRICK WALL.

1276. The wall having been duly plugged, and the uprights adjusted

by means of the plumb-level, these must be fastened to the wall. Next the horizontal piece E F, the slanting piece C D, and the uprights K L, M N, shown in fig. 617, may be placed in position, and the upright D B (or A C in fig. 615) driven home to the cross-piece E F, and then nailed to the wall at the side which has also been plugged for this purpose. The pieces which compose the end to the right as shown in fig. 616 must now be put together up to and including the post D X (B D in fig. 615). As soon as this is done the three uprights E F, G H, K L in fig. 615 must be put in place, and then the cross-piece A B must be driven down on to the tops of the uprights, and the slanting pieces C D and X Y dropped at the ends D and X into the dovetails made to receive them at the ends A, B of the cross-piece A B, and the whole securely locked together. Every mortise and tenon joint should now be fastened with nails or pins, rendering the frame-work, if it has been carefully fitted together, solid and immovable. It will have taken the amateur a long time to prepare his frame-work, and his progress will appear but slow; but the pieces of which it is composed, when once cut out and adapted to each other, will be put together with a rapidity that will afford a marvellous contrast to the apparently slow rate at which he has hitherto been proceeding.

Putting frame-work in place.

1277. The frame-work or skeleton of the building being complete, it is now ready to receive the slabs which form the outer skin of the structure, as it were. The slabs, as it has been said, are very accommodating, especially for the requirements of the amateur. They can be cut with an old saw, but the saw should at least be of good steel, and bored with brace-and-bit; so there will be no difficulty in screwing them to the uprights, and in cutting them at the sides so as to suit the slant of the roof.

Cutting and boring slabs.

1278. The dotted lines in figs. 615, 616, 617 show the positions occupied by the slabs when they are put in place, and by counting the rectangles it will soon be seen how many slabs are required. For the front 13 will be wanted, or 12 only if the space F Q T L is filled in with wood; we will, however, reckon 13. For the end to the right hand 11 are necessary, and for the end to the left hand 5, making in all 29. Say, then, that 30 slabs are purchased, to make sure of enough in case of an accident happening to any one of them, in which case it will be convenient to have a substitute. As lining slabs, 1in. thick, will be good enough and strong enough for a building of this kind, and as a lining slab costs no more than 1s. 9d., the total cost of 30 slabs for the walls will be £2 12s. 6d., by no means a large sum considering the

Positions occupied by slabs.

Estimate of number required.

size of the building, and the fact that you have a wall durable, imperishable, and impervious to water, which brick-work is not. Of course carriage must be added to the prime cost of the slabs, but this will depend entirely on the distance that the purchaser lives from London, and the mode of conveyance.

1279. As all the slabs are fixed in precisely the same manner, it will be sufficient to describe the method of attaching one of them to the frame-work, and this shall be the lowest slab in the left-hand corner of fig. 615, for this slab will naturally be the first to be fixed. In fig. 619 let A represent the sill CD in fig. 615, and B, C the uprights CA, EF, which are 4in. wide. Draw with a pencil and large wooden square the line DFE 2in. from the left-hand edge of the slab, and the line GHK 1in. from the right-hand edge of the slab; the reason why these distances are taken will be obvious when the width of the uprights and the position of the slab is taken into consideration. Then at the points D, F, E and G, H, K gently break the surface of the slab with a punch, and with a ¼in. bit bore holes through the slab at these points, using a counter-sinker afterwards, so that the heads of the screws may be sunk a little below the surface of the slab. This done, the slab must be lifted into its position and fixed in its place by six ¼in. screws, 2in. long, having a deeply-cut thread. Four screws are generally considered sufficient to hold a slab, but it is better to be on the safe side and put in too many rather than too few.

How slabs are attached to frame-work.

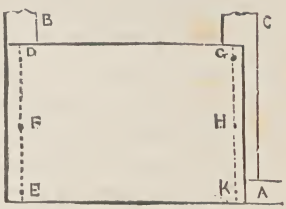


FIG. 619. MODE OF FIXING SLAB.

1280. The lowest course of slabs must now be fixed all along the front; and before putting the second slab in its place the edge of the slab just fixed should be smeared with a little fine cement or plasterers' putty, so as to form what is termed a putty joint. This should be done in every case where the ends or sides of slabs meet and touch. When the first and lowest course has been fixed, the second must be put on in the same manner, and it will be found that the top of this course will come just level with the top of the cross-pieces MN, OP in fig. 615. The two slabs one above another on either side must then be fixed to the frame-work, and the space FQTL filled in with portions sawn from a whole slab of the proper size to fit in, or left to be filled in with wood. It is preferable to use the concrete slab, so that the whole surface of the front may be uniform in appearance.

Fixing lowest course of slabs.

Putting remainder in place.

Fixing rafters of roof.

1281. The slabs at either end of the building must now be put in their places; but before this is done it will be desirable to fix the rafters of the roof, which indeed may be done before the slabs are fastened to the front. If the roof also is formed of slabs five will be required, and these must be long enough to project at least 2in. beyond the face of the front of the structure, and the same distance over the outer face of the wall which forms the back. As a suitable lodgment for the rafters, the upper course of bricks may be removed and a solid wall-plate substituted, as shown in section at Y in fig. 616 and C in fig. 617—these letters are used to avoid the addition of fresh letters—planed at the top to a slope coincident with the slant of the rafters, so that they may be bedded on it without being notched so as to fit over it. To sustain the lower ends, and to prevent notching them, thin wedge-shaped pieces of wood may be put under them between their under surface and the upper surface of the rail that forms the top of the frame-work in front. It will be well to make these rafters 4in. in width, so as to admit of means being taken to arrange the slabs at the top in such a manner that they may project for a short distance over each side of the building, instead of being flush with it, as would be the case if the slabs were put edge to edge along the length of the roof.

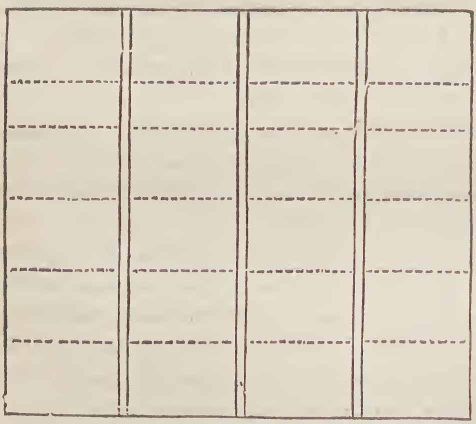


FIG. 620. PLAN OF ROOF OF CONCRETE SLAB BUILDING.

FIG. 621. END OR BOTTOM OF ROOF.

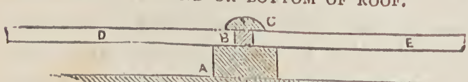


FIG. 622. CAP OVER FILLET ON RAFTER.

Preparation of rafters for slabs.

1282. When the rafters are fixed in position and securely nailed down, nail or screw a fillet 1in. square down the centre of the three rafters that lie between the outer rafters on either side of the roof, from top to bottom. This will leave a projection 1½in. in width on each side of this central rib, on which the slabs may be laid and

to which they may be screwed. The roof is shown in plan in fig. 620, and the end or bottom of the roof in front exhibiting the joists, the fillets; and the slabs are shown in fig. 621. The slabs are laid on between the fillets, and screwed down to the rafters below. The breadth of the roof from top to bottom will be just about 11ft. 3in., and to cover this space exactly one course of slabs must be cut to a width of 15in. It is better to make this either the topmost course or the second course from the top, as shown in fig. 620. To prevent ingress of rain there must be a putty joint between each slab in the direction of its length.

Laying on the slabs.

Preparation of putty joint.

1283. To make all secure the roof must be finished by a cap about 3in. wide and 1in. or 1½in. thick, rounded at the edges and screwed down to the fillet as shown in fig. 622, in which A represents the rafter in section, B the fillet, and C the rounded cap, D and E being the slabs on either side of the fillet. The open spaces A, B, C, D in fig. 621 must be blocked with pieces of wood, let in between the rafters before the slabs are put on; and to hide the ends of the rafters a slip of wood, 4in. wide and from ½in. to ⅞in. thick, should be nailed along under the eaves formed by the projecting slabs from end to end of the front of the building. A moulding may be used if preferred, but a plain slip will afford better means of fixing a gutter to carry off the water.

Finishing roof with cap.

1284. Returning now to the front, as shown in fig. 615. The spaces between Q M and T P which the slabs have not covered must be filled in with wood, after a sill has been fitted between the uprights and bedded on M N and O P, being notched into the uprights so as to be flush with the inner side of the cross-pieces and projecting at least 3in. over the slabs. A piece of wood of the width of the upright must be nailed to the upright between the sill and R, S, making the front all flush with the exception of the sill. Casing may then be put round the openings Q M N R and S O P T, to which casements may be hung and suitable stops attached inside, against which the windows may fall when shut.

Completion of the front.

Casing for casements.

1285. Turning to fig. 616, the same thing must be done at the opening for the doorway: a piece of wood must be put on from D to G sufficiently wide to be flush with the *inner* face of the upright D X on one side, and the outer face of the slabs, shown by the dotted line to the left, on the other side. The exposed parts of the cross-piece G H and the upright U H must also be covered in, after which the opening G H D U may be cased in, a strong oaken door-sill from 1½in. to 2in. thick having been first

Completion of end with doorway.

nailed to the sill D U, and then the door-stops may be nailed to the casing and the door hung. Between the outer edge of the top slab in the right-hand upper corner of the front and the outer edge of the top slab in the left-hand upper corner of the end above the door, there will be an angle 1in. square and about 14in. long, that may be neatly filled with cement: this must also be done in fig. 617, to fill the angle that will be left between the slabs at the end and in front. By making the sides an inch shorter, or by making the front 2in. shorter, the front slabs might have been caused to lap over the ends of the side slabs and hide them from view; but if this had been done, it would have been necessary to have cut a groove in the brick wall at the left-hand side of the front, in order to make room for the projecting ends of the slabs. When the slabs have been fixed the groove can be made good by filling it with cement. The patent concrete slabs manufactured by Mr. W. H. Lascelles are in every sense of the word a boon to the amateur builder, for they save him all the trouble and dirt involved in building with brick or stone and mortar, and, in addition to this, they have the commendable qualities of being cheap, durable, and easily worked. Provided that the amateur has a fair knowledge of carpentry, and can put up his frame-work true and square, there is no building necessary for home purposes out-of-doors that he cannot put up. The slabs also furnish a good roof which is easily and quickly made, and may be walked on at pleasure without fear of doing it any injury.

Overlapping of slabs.

1286. As it has been pointed out before, there are many other uses to which these slabs may be applied; and chief among these uses is that they may be substituted for paving-stones and tiles and for slate in the manufacture of tanks. In addition to these they may be cut into strips and used as shelving when supported on brackets.

Other uses for slabs.

1287. When used as paving it is desirable that a bed of concrete should be first laid, on which the slabs are bedded in cement. It is not absolutely necessary that this should be done, but by proceeding on this plan a better, and perhaps more durable, pavement may be secured. If preferred, they may be laid on the bare earth, which, however, should be properly bevelled and beaten to receive them on a solid substratum; or, if ventilation below is desired, they may be bedded on or screwed down to sleepers of wood in the same manner that the roof was made; but, unlike the roof, there must be no fillets of wood between the slabs, but they must form an even surface, broken only by the lines in which they meet. When

Paving with concrete slabs.

used as pavement it may, perhaps, be desirable that they should break bond.

1288. In making a tank five slabs will be required, and it will be better to use for this purpose the plain slabs, which are $1\frac{1}{2}$in. in thickness. They require no grooving and holding together with bars of iron passed through the ends of the sides, and screwed up with nuts so as to make the sides fit closely to the end pieces, which is done in all tanks or cisterns made of slate. All that is necessary is to take a slab for the bottom, and on it, close to the edge on either side, to place two other slabs on end, fastening the bottom slab to them with screws. This is shown in fig. 623, in which A is the bottom slab and B and C the side slabs represented in section. As the plain slabs are 3ft. long, 2ft. wide, and $1\frac{1}{2}$in. thick, the width of the ends *between* the inner faces of the sides will be 2ft. *minus* 3in., or just 1ft. 9in. To get the ends, therefore, two slabs must be sawn to the required width, and inserted between the sides as D, and then holes must be bored with the brace-and-bit, and the bottom and sides closely screwed up to the ends. The joints on the inside and the outside may be finished and rendered perfectly water-tight with cement or red lead.

Construction of tank with slabs.

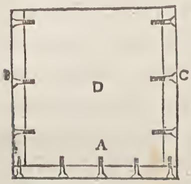


FIG. 623. CONCRETE SLAB TANK.

1289. For shelves they may be used of the full width if supported on a suitable bed, or if narrow ones are needed the slabs must be cut into pieces of the desired width. They form imperishable shelves for greenhouses, and are cool and easily kept clean when used in the wine cellar, pantry, or dairy.

Slabs as shelves in greenhouses, etc.

1290. It is necessary to finish all buildings, of whatever kind they are, with a gutter, so as to carry off the water when it rains and prevent a continual drip from the eaves on to the ground below, which splashes the lower part of the front of the building and keeps it in a chronic state of dirtiness. Owing to the ease with which the concrete slabs may be bored with a brace-and-bit, and the readiness with which screws can be inserted into them, brackets can be easily attached to the front of the building that has been described in this chapter, to carry a light zinc gutter, from which the water must be allowed to escape into a drain or on to the ground below by means of a vertical pipe attached to the gutter.

All roofs should be provided with gutters.

1291. We may fairly conclude this chapter with a short account of the method to be followed in building a shed in wood, merely pre-

mising that the same plan and style of building is to be followed as in the structures already described, and that the frame-work is very nearly the same. We shall, therefore, deal with the external covering of the frame-work with wood, giving two methods of doing this, and describe a useful mode of providing a wooden building with an ornamental gutter.

Building a shed in wood.

1292. With reference to the methods of covering a wooden frame with a coating or skin of wood, one may be described as the *horizontal* method, usually called "weather-boarding," and the other as the *vertical* method.

Methods of covering wooden frame.

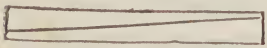


FIG. 624. FEATHER-EDGED BOARDS.

FIG. 626. SECTION OF WEATHER-BOARDING.

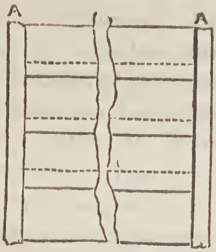


FIG. 625. FILLET IN WEATHER-BOARDING.

1293. For weather-boarding, boards thinner at one edge than at the other, usually called feather-edged boards, are used. These are made by sawing a board in two pieces by a diagonal cut, as shown in fig. 624. To give a finish to weather-boarding a fillet should be nailed to the outer edge of the upright at either end of the space to be boarded over, as shown in fig. 625 at A A. This forms a rebate within which the ends of the boards are dropped and hidden from view. The appearance presented by weather-boarding in section is shown in fig. 626.

Weather-boarding.

1294. For weather-boarding the uprights should not be more than 18in., or at the utmost 2ft. apart, but then they need not be more than 2in. square, or 2¼in. by 2½in., unless the building is to have an upper story. If it is found convenient to place the uprights at a wider distance, diagonal braces should be introduced to strengthen the frame-work, and this may be done with good effect even when the uprights are close together.

Distance between uprights.

Strengthening by diagonal braces.

1295. If this system of strengthening by diagonal braces is desirable for weather-boarding or horizontal boarding, it is even more desirable for vertical boarding, in which the boards are nailed to the frame-work perpendicularly edge to edge, or grooved and tongued, because the diagonal pieces afford means of nailing the boards to the frame-work at other points than at the top and bottom only. In fig. 627 a representation is given of vertical boarding in elevation, and in fig. 628 the same is shown in section. The boards

Vertical boarding.

are simply placed edge to edge and nailed to the frame-work of quartering behind, battens or slips of wood about 2in. wide and from

How to hide the joints. ⅝in. to 1in. in thickness being nailed to the boards, so as to hide the joints as shown in the diagrams. This branch of building in wood need not be pursued any further, as from all that has been said the amateur will be able to finish a building in this style without more instructions in detail. The method saves a great deal of trouble in tonguing and grooving, and when the boards shrink, as they will under the drying influence of the sun in summer, the batten will prevent any un-

FIG. 627. VERTICAL BOARDING (ELEVATION).

FIG. 628. VERTICAL BOARDING (SECTION).

Suitable for roofing. sightly chink from showing itself. For roofs, and, indeed, for the front and sides of wooden buildings, this mode of covering the frame-work with vertical boarding is preferable to weather-boarding, for the water has a clear uninterrupted run from top to bottom in the direction of the grain of the wood. In weather-boarding the water has to trickle as it were from step to step in its downward course, and as the grain of the wood is horizontal in position there will be a tendency on the part of the water to spread to the right and to the left. Of course much of this is obviated when the boarding is painted.

1296. In some cases it may be desirable to make the walls of a building of this kind as air-tight and impervious to damp as possible.

Boarding buildings within. To do this an *inner skin of horizontal boards* should be nailed to the frame-work and the vertical boards nailed over these. The *inside* of the frame-work should also be boarded over, and the space enclosed between the uprights and other parts of the frame-work and the boarding nailed to them on either side, be filled with some nonconducting material.

1297. Ashes, or even sawdust, with shavings will do for the packing

Filling up between the boards. to be placed between the boards, but some difficulty will be found in filling the interstices completely with this material. A better way is to dispense with the inner skin of boards on the outside, and to cover the frame-work outside and

Anglo-Danish Roofing Felt. in with the Anglo-Danish Patent Asphalte Roofing Paste-board, sold by MESSRS. H. ATKINSON AND CO., 33, *Wharf Road, City Road, London, N.*, at the rate of 1d. per square foot. A fuller account of this cheap and excellent material will be found in a subsequent chapter.

1298. Referring once more to the battens with which it is usual to cover the joints of vertical boarding, a lighter and more elegant appearance will be given to the wood-work if the sharp edges of the batten on the outside are bevelled away, or, as it is technically called, "chamfered." It is always desirable, too, to finish a building of this kind at the bottom with a box and cap, or with a piece of wood attached to the face of the wall at an angle, and called a dash-board. It prevents much of the splashing during heavy rain, which tends to make the bottom of a wooden building dirty, and therefore unsightly until the eyesore can be removed.

Battens on vertical boarding.

1299. What is meant by chamfering the edges of a piece of wood is shown in fig. 629, from which it will appear that it is simply planing away the sharp angles at A and B, so as to present in their stead a flat face on either side. The mode of finishing a building with a box and cap is shown in fig. 630 in section. In this A A is the vertical boarding, B a block of wood, some of which should be set at intervals along the bottom of the boarding of 12in. or 18in. to afford support to the box-board C, which is nailed to them. Above the blocks and box-board is nailed the cap D, bevelled from back to front so that no water may lodge on it, and fitting over the cap is the batten E. The dash-board is put on in much the same way, and for this an inclination of about 45° will be found convenient, as shown in fig. 631. In this illustration A A is the vertical boarding, B one of a series of triangular blocks nailed to it to afford a support for the dash-board C, on the top of which the batten D is bedded. For a door, a dash-board may be attached without supports as at B, or it may be made out of a solid piece sloped at the top as at C, and "throated" or channelled on the under surface with a deep groove to prevent any possibility of water trickling from the dash-board under the door. In such a case the bottom of the dash-board would be at right angles to the face of the vertical boarding, as shown by the dotted line E F, and the throating would be made at E.

Chamfering edges.

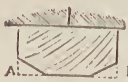


FIG. 629. CHAMFERING.

Box and cap.

FIG. 630. BOX AND CAP.

Dash-boards.

Dash-board on door.

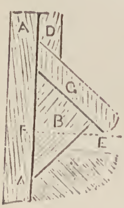


FIG. 631. DASH-BOARD.

1300. We may fairly conclude this chapter on building within the

scope of the amateur by describing a useful mode of forming a gutter to a wooden building, by which all recourse to the plumber, zinc worker, or smith is avoided. This kind of gutter forms a substantial part of the building, and has the merit of being capable of ornamentation with very little trouble, thus forming a suitable and pretty finish to any wooden building of no great size.

Wooden gutter for wood building.

1301. We will suppose the roof to be rectangular in form, sloping in a single piece from back to front. The frame-work in the front has been been fixed, and A B in fig. 632 is the rail which forms the uppermost member of the frame. A piece of quartering must now be taken, say 2½in. square, and this must be sawn lengthwise in a slanting direction from end to end, so as to be separated into two pieces of the shape shown at C D and E F. If the wood has been properly sawn these two pieces will be equal and similar in every respect. Let us suppose that the water is desired to run from B in the direction of A, where a shoot or pipe will be attached to the gutter through which the water may escape. To effect this the part C D must be nailed on to A B, so that the thin end C may be at the end A, and the thick end D over B. On C D we must now nail a board, shown in section in G H in figs. 632 and 633, lengthwise in the former, crosswise in the latter. This board may be from 6in. to 8in. wide, and should be

How to make the gutter.

Board for bottom of gutter.

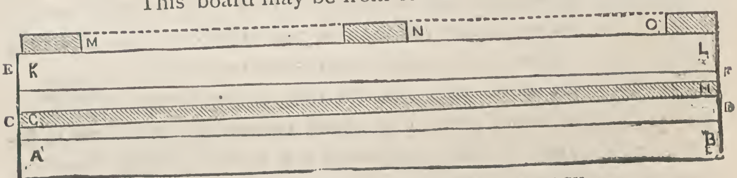


FIG. 632. ELEVATION OF GUTTER AT THE BACK.

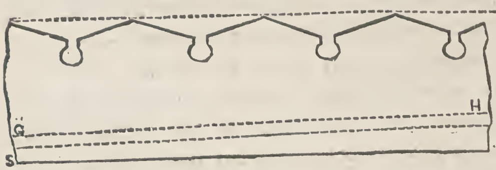


FIG. 634. CREST BOARD IN FRONT OF GUTTER.

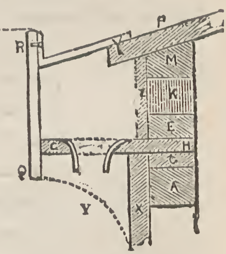


FIG. 633.
SECTION OF GUTTER, ETC.

at least 1 in. in thickness. It will project from 4in. to 6in. beyond the face of A C E K M, etc.; and, if necessary, after the vertical boarding

X has been nailed to the frame, extra support may be given to it by three or four brackets, as shown by the dotted line at Y. On to the upper surface of this board, and just above A B and C D, so that their faces outward and inward may coincide, must be nailed the piece E F, the thick end being over A, and the thin end over B. By this the upper surface of E F is, or ought to be, level, and to give sufficient depth to the gutter another piece of quartering, K L, may be nailed on E F, and this last piece will carry the rafters shown in section at M, N, O.

1302. To finish the gutter within, a piece of wood Z, as shown in section in fig. 633, should be nailed from end to end, so as to cover E F, K L, and the ends of the rafters reaching up to the dotted line at the top of fig. 632. The ends of the vertical boards, or rather boards placed in a direction from top to bottom of the roof, will hang over Z, as shown at P in fig. 633, and carry the water into the gutter.

Finishing gutter within.

1303. The front of the gutter will be formed by nailing to G H a piece of wood from end to end, put on in such a manner that the bottom of the board may be level with the lower part of C D, or even lower than this, taking care always that the bottom of this board is horizontal and has to G H the relative position shown by S T to G H in fig. 634. A row of holes may be bored with a brace-and-bit, as shown in this figure a little below the upper edge of the board, and pieces taken out with the saw between the holes, so as to give the board an ornamental appearance. Many different forms of ornamentation will readily suggest themselves to the ingenious amateur. The crest-board thus formed may be carried as high, within reason, as the maker chooses, so as to afford more scope for ornamental cutting; in any case, whatever may be the length or height, it will be well to support it and attach it to the roof by iron stays, as shown between R and P in fig. 633. Any blacksmith will make three or four of these at the necessary angle to fit the upright crest-board and the sloping board of the roof for a few pence.

Front of gutter.

Ornamentation of front.

Iron stays.

1304. Fig. 634 will suggest to the amateur many other uses for boards ornamented in a similar manner, or crest-boards as they are generally called. When a building, for example, has been made with a span-roof, sloping on both sides, a board of this description may be placed in a grooved cap over the ridge-board and the lines in which the rafters are butted against the ridge-board, affording an appearance very much like that exhibited by ornamental ridge-tiles.

Crest-boards: how to fix them.

CHAPTER V.

MASONRY AND THE WORK IT INVOLVES.

Masonry that can be done by Amateurs—Mason's Work neither Attractive nor Easy—Knowledge of Masonry necessary for the Amateur—Modes of Building in Stone—Rubble Work—Coursed Work—Ashlar—Building Materials peculiar to every District—Bath Freestone—Limestone and Slate—Granite—Sawing and Dressing Stone—Reducing surface of Stone—Designations of various kinds of Mason's Work—Plain and Sunk—Circular and Moulded—Rusticated—Fixing Mason's Work—Construction of Chimney-piece—The Slabs—Plinth and Necking—Frieze and Shelf—Variations in Form—Plaster of Paris—Fastening down loose Flag-stone—Substitutes for Paving-stones—Mode of making Substitute—The Mould—Filling the Mould—Floor of Greenhouse—Making or Repairing Step—Clearing ground for Foundation—Bed of Cement for Slab—Size of Slab—Brick-work below Slab—Step formed of Concrete only—Instructions given apply to other Operations.

1305. If the amateur does but little to bricklaying, he will do still less with masonry, which involves the cutting of different kinds of stones in order to fix them into certain places. If a house or wall is to be built entirely of stone, then the mason is called into requisition instead of the bricklayer. His chief work, in addition to building with stones, is cutting and fixing stone lintels and sills to windows, lintels to doors, and all the stone-work that may be required in a house built of brick, such as keystones to arches, when cut in stone, sinks, doorsteps, and stone paving of all kinds. In addition to this he has to cut the slabs of which stone or marble mantelpieces are made, and fix them in their respective places.

Masonry that can be done by amateurs.

1306. Now it is evident that an amateur will do little, if anything, of this kind; he will rather leave such work to the regular artisan, for it is neither attractive nor pleasant, involving the chance of getting splinters of stone into the eyes while dressing them into shape with the mason's mallet and cold chisel, and the lifting of heavy weights, and, perchance, bruising, or even crushing, his fingers or toes, if, by some maladroitness on his part, a heavy stone fall on them.

Mason's work neither attractive nor easy.

1307. All that will be necessary for the amateur to know with regard

to masonry will be the different forms in which walls of stone are built, and the names assigned to the various styles; the terms technically applied to various kinds of mason's work; and the nature of some of the stones employed for walls, dressings, and pavement. Beyond this, it will be certainly useful to know how a mantel-piece is put together, though he may never attempt to do it. His utmost efforts in masonry will, in all probability, be limited to fixing a garden step that has been dislodged from its position, or cementing a flag-stone that has been loosened. In fact, his work will chiefly be with cement, and in dealing with this, he may make blocks of artificial stone and paving-stone to serve his purpose, and the *modus operandi* to be followed in doing this shall be fully described.

Knowledge of masonry necessary for the amateur.

1308. Let us first consider the different ways in which walls are built of stone, and the names that are applied to these various modes of building. The way in which stones are built together by the aid of mortar to form walls are shown in figs. 635, 636, and 637. The mode of building represented in fig. 635, is termed "rubble work." In this the pieces used are of all shapes and sizes, the stones are not squared or even dressed so as to be fitted together, but are put together as they may best suit. As in brick-work, a proper bond is obtained by laying the stones in such a manner that the line of division between any two stones comes over the middle, or as near the middle as may be, of the stone below, on which the ends of the contiguous and superincumbent stones jointly rest. In "coursed work," shown in fig. 636, some attempt is made to preserve regularity as regards height in the stones that form any single course, stones similar in depth being selected for each individual course. In "ashlar" the stones are squared according to dimensions duly laid down, and put together very much after the manner of brick-work. In this kind of work, pointing is seldom, if ever, required, but in coursed work and rubble work, when the wall is set, the joints between the stones are raked out and finished with flat-pointing.

Modes of building in stone.

FIG. 635. RUBBLE WORK.

Rubble work.

FIG. 636. COURSED WORK.

Coursed work.

Ashlar.

1309. Every part of the country has some building material underlying the surface of the earth, either in the form of brick-earth or stone, but these widely different substances are rarely found in juxtaposition. In Kent there is abundance of brick-earth, with chalk and flints, of which chalk can be converted into lime for making mortar, and flints can be worked up into durable and ornamental walls, the quoins or corners of the walls being made of brick. In this country occurs also the famous Kentish rag-stone, so much used in bold rubble work for churches, houses, walls, etc.

Building materials peculiar to every district.

FIG. 637. ASHLAR WORK.

1310. In Bath and its neighbourhood is found the soft cream-coloured oolite called "freestone," easily worked and used with Caen stone, a similar material, for dressings, sills, lintels, and sometimes for the entire façade of buildings of importance. In Devonshire, on the bleak heights of Dartmoor, granite is quarried, while along the coast is found limestone of excellent quality used for making lime when calcined or roasted under intense heat, and affording a beautiful and variegated marble when polished, and the Indian-red conglomerate known as "old red sandstone." Devonshire and the southern part of Wales also abound in fine slate of a purple and green tint, and in the former there exist, in parts, large quarries of a laminated slaty stone, which readily splits in thin pieces of great size, which are set up on end one after another to form rough fences, or the walls of pig-styes and similar buildings.

Bath freestone.

Limestone and slate.

1311. Granite is found of excellent quality in Cornwall and the northern parts of Scotland. Dorsetshire is noted for its Portland stone, and a fine limestone known as Purbeck stone, which was much more used in olden times than now. Space, however, would fail to mention the various kinds of stone which are quarried in the different counties of Great Britain, and we must be content with just calling attention to the close-grained light-brown sandstone of Yorkshire, of which steps and landings are made, and which furnishes so much of the stone pavement used in our streets.

Granite.

1312. Stone that will not cleave with any degree of certainty is cut into pieces of the necessary size and shape by means of a saw, generally worked backward and forward by two men sitting opposite one another, one on either side of the block that is being sawn. The face of building stone, and stone for

Sawing and dressing stone.

pavement, is usually dressed with a broad cold chisel, held in one hand and struck by a mallet of the shape shown in fig. 638, round in form and sloping gradually from a broad top to a narrower bottom. Chisels of different widths are used by the mason in dressing stone for building purposes, and sometimes the axe, or mason's hammer, already figured in a former chapter, is used in dressing stones for walls. The other tools are a trowel, about 7in. long in the blade and 5in. in the handle, the upper surface of the blade being about 1½in. below the centre of the handle or the tang which enters the handle, and the A level, plumb-level, and spirit-level, and squares of wood and iron.

Fig. 638. Stone-mason's mallet.

1313. In Burn's "Handbook of the Mechanical Arts" the following practical description is given of the mode followed by the mason in bringing a stone, as one intended for a hearthstone or the tread of a step, to a flat surface with a chisel. First, "two chisel draughts are made at one side and the end of the stone something like what in joinery is termed a rebate. These rebates are made perfectly flat, which is tested by means of a straight-edge. Every part of the stone (in the rebates) should coincide with the under side of straight-edge. A diagonal chisel-draught is then made, connecting the ends of the side and end draughts previously made. Another diagonal draught is made crossing the first diagonal, and meeting the angle of the end and side draughts. All these being made as near as possible of the same depth, on the spaces between the draughts being blocked out, a comparatively flat surface is obtained. This is brought as flat as required by the use of the square; or the level of the surface may be tested by using two straight-edges of equal depth, thus: place one along an edge or arris of the stone, and on the opposite one the other straight-edge; by looking over the upper edge of the one straight-edge, if the upper edge of the other coincides, the surface is level." The foregoing description may prove useful, in case the amateur should attempt to re-dress the surface of a stone from which some thin layers have been split in any part, and which makes a depression that disfigures the stone.

Reducing surface of stone.

1314. Mason's work is differently described by the architect and builder, according to the form that it assumes. Thus it is "plain" when the rough surface of the stone is removed to produce a flat and level face. When any

Designations of various kinds of mason's work.

part of the stone is sunk below the surface, as in a rebate, panel, or cornice, the work is said to be "sunk." When work is rounded or hollowed out, so as to form convex or concave surfaces, it is said to be "circular." All cornices, heads of columns, etc., are said to be "moulded," and moulded work is distinguished as straight or circular, according as it runs along in a straight line like a cornice, or is round in form like the capital or head of a column. When irregular holes are sunk below the surface of any stone, the work is spoken of as being "rusticated" or "vermiculated."

Plain and sunk.

Circular and moulded.

Rusticated.

1315. In fixing all mason's work, it is first of all necessary that the pieces of which it is composed, whether it be for steps or a chimney-piece, a door or window-sill, or a lintel, be truly cut. The foundation on which it is to rest, if it be a door-step or a sink, must be properly prepared, so as to give a slight inclination to the stone, that the rain may run outwards from the door, or trickle to the corner of the sink in which the escape pipe is fixed. Chimney-pieces are distinguished as flat or box, according as they consist of jambs and frieze, formed of single pieces, with a mantel-shelf above them, or in many pieces, so as to project boldly from the wall, and give the appearance of solidity.

Fixing mason's work.

1316. It will sometimes happen that a chimney-piece may, through damp or other means, be dislodged from its position, the mischief being completed when the fastenings are loosened by some one hanging on to the mantel-shelf, as servant girls are accustomed to do, when rising from before the fireplace after cleaning the grate. A little plaster of Paris and cement is all that is required to put everything to rights again. To make the construction as clear as possible, let us take the case of a chimney-piece of simple form, as shown in figs. 639, 640; it will be enough to show and describe one jamb only, as both jambs are made in the same way, and it will help us a little to suppose that the material used is glass instead of marble, so that we may see through the outer slabs to the pieces within which

Construction of chimney-piece.

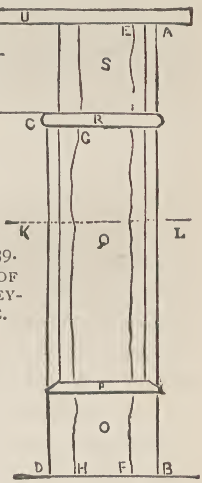


FIG. 639. JAMB OF CHIMNEY-PIECE.

FIG. 640. SECTION OF JAMB.

are partly covered, and therefore hidden by them. First, two pieces of marble, polished on the face and one edge, are reared against the wall at the back—a longer piece A B on the outside, and a shorter piece C D on the inside—and these pieces are secured in their place by iron cramps set into holes cut to receive them, and set in place by cement or plaster of Paris, with which the lines of junction between the marble slabs and the wall in rear are liberally plastered. The rough, irregular lines, E F, G H, show the inner surface of these slabs, which are also shown in section, along the dotted line K L, at M and N, in fig. 640. Against these slabs, at the very bottom, and resting partly on the hearthstone, is set a square piece O, which extends from face to face of the slabs, generally speaking, and is called a plinth. On the plinth is placed a necking P, rounded or cut like a moulding. Both plinth and necking are set to the slabs at the back by plaster of Paris. On the necking is reared a slab Q, less in width than the plinth by 1½in. or 2in.; which, when it is fixed in the place, has the effect of making a rebate of ¾in. or 1in. on either side. On top of this another necking R is placed, and then all is ready to receive the frieze of the chimney-piece T, which rests on the short slabs on the inside of each jamb, and is secured in its place by cramps, and plaster of Paris as well. To hide the gap that is now left at the top of each jamb, and at each end of the frieze, a square block S is placed on top of the necking. The shelf U is last of all put in its place on top of jambs and frieze, and the chimney-piece is complete. Sometimes a projecting piece of carved marble, called a truss, is attached to the slab Q below the necking R, or in some cases the necking is dispensed with, and the slab Q carried up till it reaches the mantel-shelf, or very nearly so, leaving just room for a necking, below which projects a bold truss.

The slabs.

Plinth and necking.

Frieze and shelf.

Variations in form.

1317. By following the preceding description, the amateur will find little difficulty in putting up a chimney-piece that has come away from the wall behind. He must remember, however, that plaster of Paris hardens very rapidly, and that no more must be mixed at one time than is just sufficient to use with the piece to be fixed. Plaster of Paris can be bought of the oilman in paper bags, ready for use, at 3d. per bag of 7lbs. Like cement, if kept on the amateur's premises, it should be stored in a perfectly dry place.

Plaster of Paris.

1318. In fastening down a flag-stone that has been loosened, the stone must first be taken up in order to see what has led to the loosen-

ing, which may have been caused by excavations made by rats, and many other causes. The substratum having been made good, and a bed of cement laid to receive the stone, the stone must be put in its place and worked about until it is exactly on a level with the stones around it. The joints may then be filled with cement.

Fastening down loose flag-stone.

1319. It has been said that the amateur himself may make excellent substitutes for paving-stones and building-stones—or, in other words, artificial stone for any purpose that he may require. This is simply another way of making and using concrete, and it will often be found very useful.

Substitutes for paving-stones.

1320. Let us imagine that in a paved way, consisting of a number of single stones of the same width laid end to end along the centre of a path, as is often the case, so as to afford means of access from one point to another without treading on the damp earth, that a stone has by some mischance become cracked or worn away in the centre. If cracked, the pieces will soon become loose and dangerous, especially to children ; and if worn into a depression in the middle, water will collect and stand there, if the path be exposed to the weather. The amateur desires to mend this without having recourse to the builder for a new stone, or to pay for putting the new stone in its place. The first thing to be done is to measure accurately the length and breadth of the stone to be replaced, and to make a shallow wooden mould of the same length and breadth *between the opposite and interior faces* of the sides of the mould. Thus, if the stone to be replaced measures 2ft. by 1ft. 6in., make the sides of the mould so that the distance within from A to B, and from C to D, be 2ft., and from A to C, and from B to D, 18in. The figure represents the plan of the sides of the mould, and to complete it some boards must be nailed over the frame, as shown by the dotted lines, to form the bottom of the mould. The boards that are used for the bottom of the mould should be planed smooth within, so that the face of the block formed within the mould may also be smooth. In filling the mould the first thing to be done is to provide for the face of the stone, which may be done by putting in a layer of cement of the thickness of $\frac{1}{4}$in., and on this some cement and sand, the two layers forming the thickness of $\frac{1}{2}$in. The remaining space should be filled up with concrete of cement, sand, and gravel. The

Mode of making substitute.

The mould.

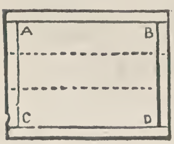


FIG. 641. MOULD FOR PAVING-STONE.

Filling the mould.

work should be done as quickly as possible, that one layer may not get too dry before the next is put on. When the mould is filled, it must be put on one side, and left for two or three days to allow the contents to harden and dry out completely. When this is effected, it will be found that the conglomerate of cement, sand, and gravel has shrunk, and that the stone will easily slip out of the mould. If the stone required be large, it is better to make the length and breadth of the mould a trifle more than the actual length and breadth required for the stone, to allow for the shrinkage of the cement. With patience and two or three moulds, the amateur may soon make stone enough to cover a considerable space. This will be useful for a long pathway; but for a greenhouse, workshop, or any similar building, it is better to make the floor all of one piece, with concrete thrown in, levelled and faced with cement.

Floor of greenhouse.

1321. If a garden step or any other step with a treader of stone is required to be made, or if the treader of any such step has become dislodged, the first thing to be done in the one case is to make, and in the other to see to, the base on which the treader is laid, and which acts as the riser of a wooden stair in giving the necessary support and height to the treader. In this case, let us suppose that a step has to be made to afford access to a roadway that is elevated about 15in. or 18in. above the level of the garden within. The example will serve for any other kind of step or steps constructed in a similar manner.

Making or repairing step.

1322. The general method to be adopted in making steps of stone, and the necessary foundations for them, may be gathered from an inspection of fig. 642, which represents the end elevation of such an ascent from the ground-level A, to a higher level B, as suggested above. The ground must be cleared out to the depth of two bricks' thickness below the surface, and on this, after it has been well rammed, brick-work or stone-work must be made until the level C D is reached on which the stone E is to be placed. Rough but sound bricks should be used for the outside of this work; for the inside, which does not meet the view, any bricks or brickbats will do,

Cleaning ground for foundation.

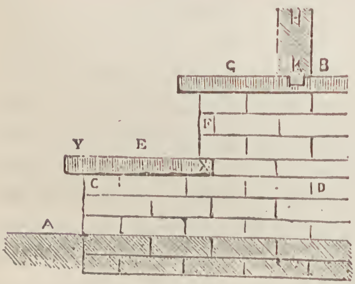


Fig. 642.
Steps of brick and stone in section.

provided that they are well set in strong mortar. When the level C D is reached, a good bed of cement should be laid on the surface, and the stone set in its place, care being taken to give it a slight inclination outwards, so that no water may settle on it. An inclination of ¼in. in 1ft. will be quite sufficient.

Bed of cement for slab.

1323. The stone should be wide enough to admit of its extending 2in. or 3in. under the superincumbent brick-work at F, which serves as the riser for the next step and landing G, which is only its own thickness above the level of the roadway without. Supposing that ingress and egress is effected through a doorway, the jambs of the door may be dowelled into the stone, as shown in the case of the upright H, at K. No step that is properly made, that is to say, in the way that has been described, ought to become dislodged, but it frequently happens that through the carelessness or ignorance of the workman employed, the brick-work has not been brought sufficiently forward at C to afford a solid foundation for the step, and the back X has not been let in under the brick-work at F, but is merely butted against it. In this case, too, mortar will be used in all probability instead of cement, and the stone may perchance have an inclination or slight slope inwards towards the brick-work instead of outwards. Water will then settle on the stone, and soak down behind it, and when a severe frost sets in the stone will be loosened by the frost's action, and the weight of a man or woman resting on the outer edge at Y will lift it if it does not tip the stone up and wrench it right out of its place. In such a case the only thing to be done is to extend the foundation, and with a cold chisel cut away a groove in the brick-work behind sufficiently deep to let X at least 1in. under the brick-work above at F.

Size of slab.

Brick-work below slab.

1324. It will, of course, be readily understood that the amateur may, by the aid of a mould made of a few boards, form a foundation of concrete which will answer all the purpose of brick-work, and be less troublesome to make; or he may, if he like to do so, make blocks of concrete which he may build together instead of bricks. The projections of the stone treaders beyond the brick-work below them produce a pleasing effect; but if the amateur chooses to dispense with these, he can finish his work by facing the upper surface of the steps thus formed in concrete with cement.

Step formed of concrete only.

1325. It is unlikely, as it has been advanced before, that the amateur will do anything in masonry beyond those things which have been described in this chapter. If he does, that which has been already said will afford the keynote and clue to the contrivance and

execution of many a piece of work of greater magnitude. It must, however, be remembered that it is sought to do no more in this book than to suggest work that is within the compass of the amateur, and to explain the methods to be adopted in doing it. Indeed, the remarks that have just been made may be taken to apply to the general principle on which this book has been written, namely, that of putting the amateur artisan in the way of carrying out any piece of work according to the method that is usually followed in such cases as may be brought under his notice, leaving him to apply the information that is given, and the general instruction that he has gathered from it, to the special requirements of the particular piece of work that he may happen to have in hand.

Instructions given apply to other operations.

CHAPTER VI.

THE CONSTRUCTION OF ROOFS: ROOFING WITH SLATE AND OTHER MATERIALS.

Roofs should be Weather-tight—Different kinds of Roofs—The Lean-to Roof—How Composed—Beams for Principal Rafters—Common Rafters—Adjustment of length of Rafters—Struts to Principal Rafters—Simple Roof sufficient for Amateur—Horizontal and Vertical Boarding—Lean-to Roof: when available—The Span-roof—Inclination of Roofs—Convenient Angle for ordinary Purposes—Construction of Span-roof—Proportions of Roof—Rafters—Purlins and Common Rafters—Horizontal Boarding—Cap and Crest-board—The Hipped-roof—General form of Hipped-roof—How to Construct Hipped-roof—Ridge pole and Hip-rafters—Jack-rafters—Reduction of edges of Hip-rafters—Capping to finish Roof—Extension of general Principle—Method of Construction of Gable-roof—Wall-plates and Hip-rafters—Ridge-pole and Rafters—Guttering—Covering Materials for Roof—Thatching with Straw or Reed—How Thatching is done—Mats of Wheat-straw—Materials for Roofing not yet considered—Roofing with Slates and Tiles—Laths for Slates and Tiles—Dimensions, etc., of Tiles—Gauge for Tiling—Measurement of Slating—Calculation of Number of Slates for Roof—Names and Sizes of Slates—Larger Kinds of Slates—Preparing Roof for Slates—Setting out Roof for Laths—Gauging and preparing Slates—Slater's Saxe or Chopper—Pegging Slates—Process of Setting out Roof—Facia along ends of Rafters—Inclination of First Course of Slates—Example of Wrong Method of Slating—Example of Right Method—Facia must be raised above ends of Rafters—Roofing-felt—Anglo-Danish Patent Asphalte Roofing Pasteboard—Good qualities of this Material—Buildings Covered with this Material Insured at low Premiums—Price of Material—Erichsen's Patent India Mastic—Method adopted in preparing Roof—Distance between Rafters—Ventilator in Roof—Construction of Gutters—Disposition of Rolls of Pasteboard—Driving in Nails—Covering of Span-roof—Nail in Crevice—Application of Asphalte Mastic—Sanding the Roof—Roof should be Finished in Dry Weather—To render Roof Durable and Water-tight.

1326. THE man who can make a good sound weather-tight roof can do a good and serviceable piece of work, for it is by the soundness of the roof that all things that are under it are preserved from wet, and consequent injury. In this chapter it will be useful to consider the different kinds of roofs that the amateur may be called on to make for himself, the various materials with which such roofs are covered in, and the manner in which these materials are used and put together.

Roofs should be weather-tight.

1327. And, first, with regard to the different kinds of roofs that an

amateur may construct; these may be defined as the *lean-to* roof, the *span*-roof, and the *hipped*-roof. Of these, the lean-to roof is the most simple and therefore the most frequently made, while the hipped-roof is the most difficult of construction, and will only be resorted to when it is desired to put up a structure with gables, or of a more ornamental and diversified character than the simple rectangular buildings that are covered in with lean-to or span roofs.

Different kinds of roofs.

1328. The lean-to roof, which is so called because it is composed of a single sloping piece, extending from the wall in the rear of the building to the wall in front, has been sufficiently indicated, both in general character and construction, in Chapter IV. It will be enough to remind the reader that it is composed of parallel rafters, set to the same level throughout, supported and nailed at one end to the wall-plates on the wall behind, and at the other to the wall-plate on the wall in front. It depends entirely on the material with which the roof is to be covered in, whether any cross-pieces of timber should be nailed on to and above the rafters at right angles to them. It sometimes happens that a lean-to roof is so large that it is necessary to support the rafters, then called *principal* rafters, on horizontal beams, extending from the wall at back to the wall in front, uprights being mortised to the beams where they rest on the wall-plate let into the wall behind, in order to give support to the ends of the rafters that butt against the back wall. Larger rafters are then used, and these are placed at a greater distance from one another; to compensate for this, however, and to afford sufficient support for the roofing material, be it what it may, long horizontal pieces, called purlins, are let into the rafters, their number being determined by the width of the roof from back wall to front wall, and the rafters being slightly notched to receive them, and on these smaller rafters are laid at less intervals. These are termed *common* rafters, and are notched slightly on the under side to fit over the purlins. This construction will be sufficiently explained by reference to fig. 643, in which A, B, are wall-plates in the walls in rear and in front, supporting the ends of the beam C. Along the ends

The lean-to roof.

How composed.

Beams for principal rafters.

Common rafters.

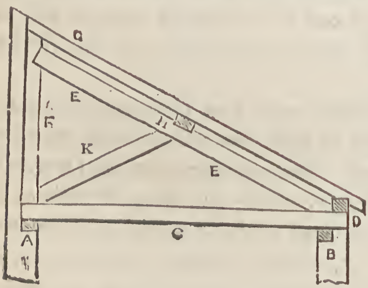


FIG. 643. RAFTERS IN LEAN-TO ROOF.

of the beams thus placed, a timber shown in section at D is nailed, against which one end of the principal rafter E E is butted, the topmost end being notched into the upright F, which is mortised into the beam C, and built into the wall. This upright is continued a little above the principal rafter, and affords support for the common rafter G G at the topmost end, this rafter being notched at the other end over the timber D and supported in the middle on the purlin H, which is shown in section. Sometimes, if the length of the principal rafter is from 15ft. to 20ft., it is advisable to give additional support to the weight of the roof by putting in a strut K, one end of which is mortised into the principal rafter, and the other butted against the lower end of the upright F, which is properly sloped and mortised to receive a tenon which is cut at this end of the strut as well as at the other end where it is connected with the rafter.

Adjustment of length of rafters.

Struts to principal rafters.

1329. It will be seldom, if ever, that the amateur will find occasion to construct a roof of this kind, the simple lean-to roof of single rafters being sufficient for his purpose. In cutting his rafters he must remember that it is more important to have them deep than thick, as the strength of a rafter is in proportion to its depth, and not to its thickness. When a roof of this description is covered with boarding, if the boards are put on horizontally either as weather-boards or to be covered with asphalte-roofing or slates, the boards may be nailed at once to the rafters without any intervening timbers. If, however, the boards are put on vertically, two or three horizontal pieces after the manner of purlins should be nailed across the rafters to which the vertical boards may be nailed, or, to give additional substance and security to the roof, one set of boards may be laid on horizontally as a lining, planed up on the inside, and the vertical boards screwed down to these.

Simple roof sufficient for amateur.

Horizontal and vertical boarding.

1330. The lean-to roof is for the most part only used when the structure over which it is placed is built against or forms an offset from another building. When the structure itself is wholly detached from any other, having four sides of walls of its own at right angles to each other, or when the purpose to which it is to be put is such as to render a lean-to roof undesirable and a gable-end preferable, even though the structure be reared against another building, a span-roof should be made.

Lean-to roof, when available.

1331. The span-roof consists of two rectangular pieces of roofing forming a certain angle with each other, and with the horizontal line

from top to top of the opposite walls on which the lower members of the roof rest. It is, in fact, two lean-to roofs put together and connected at the top where the slopes meet. The chief difference in point of structure between the lean-to roof and the span-roof is, that the rafters are placed in pairs instead of singly, and that they are butted against one another at the top, a ridge-board or ridge-pole intervening, instead of resting, as in the case of the lean-to roof, on the higher wall-plate on the wall to the rear. With regard to the slope of any roof, it must be remembered that the greater its inclination the more quickly will the rain that falls on it run off. No roof need slope at an angle greater than 45°, which is the inclination of the slanting line B C to the horizontal line A B in fig. 644, and none should be less than 22° 30′, as shown by the angle A B E. The latter slope is sufficient for all lean-to sheds; the former is usually adopted for green-houses, where it is an object to allow the sun's rays to strike on the glass as directly as possible for the greater part of the time that the sun is above the horizon. An angle of 30°, shown by the angle A B D, will be found a convenient and, at the same time, sufficient inclination for the roofs of most buildings that an amateur may put up; but in determining the slope or pitch of the roof it is manifest that he must, in most cases, be guided by circumstances of position and the purpose for which the building is intended.

The span-roof.

Inclination of roofs.

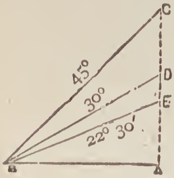


FIG. 644. INCLINATION OF ROOFS.

Convenient angle for ordinary purposes.

1332. The general principles of construction of span-roofs will be readily understood from fig. 645, which shows the kind of roof that the amateur will most generally build on this plan. In this diagram the height of the roof is taken at one-third

Construction of span-roof.

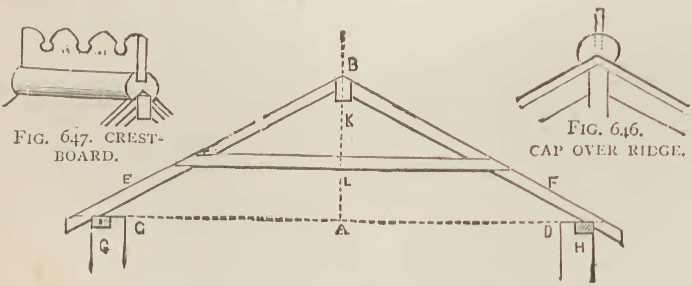


FIG. 647. CREST-BOARD.

FIG. 646. CAP OVER RIDGE.

FIG. 645. CONSTRUCTION OF SPAN-ROOF.

the span, that is to say, the height A B of the ridge B above the horizontal line C D drawn from the top of one wall to the top of the

other is exactly one-third of C D, which makes the inclination of the sloping sides of the roof to this horizontal line as nearly 30° as possible.

Proportions of roof.

Thus, if C D be 15ft., A B should be 5ft., and if the height A be 6ft., then the span C D should be 18ft. If the material of which the roof is to be formed is heavy, then the beams or rafters should be pretty stiff, that is to say, they should not be less than 6in. deep by 3in. thick; but if the roofing stuff be light, rafters of less substance, as far as depth is concerned, will do. The rafters E, F, are notched on to the wall-plates G and H respectively at their lower end, while the upper end of each is rested against the ridge-pole K. In order to give stability to the structure, the rafters are connected by a tie L, which renders the whole framework rigid. The same methods of adding purlins and common rafters if necessary, and of completing the roof, are used as in the lean-to roof, and if vertical boarding is to be used as roofing material it will be desirable to nail some horizontal pieces across the rafters from end to end, to which the boarding may, in its turn, be nailed.

Rafters.

Purlins and common rafters.

1333. Horizontal boarding may be nailed on to the rafters at once, and this may be covered with asphalte roofing-felt. This is shown in fig. 646, which also exhibits a neat method of covering the ridge with a cap, or piece of wood grooved below so as to fit over the ridge and rounded above. This may be made more ornamental by making another groove along the top of the rounded surface into which must be inserted a thin crest-board, as shown in fig. 647, which may be cut along the topmost edge into any shape that fancy may dictate. In the crest-board the grain will run along its length from end to end, and whatever may be the style of ornamentation adopted, it will be desirable not to leave too narrow a neck of wood between the lowest parts of the indentations, lest by some mischance any of the projections should be broken off, and the appearance of the crest-board spoiled.

Horizontal boarding.

Cap and crest-board.

1334. The formation of a hipped-roof is far more difficult than that of the roofs which have been described, but it may be that the amateur may require to make one. We will, therefore, endeavour to describe as briefly as may be consistent with clearness two forms of hipped-roofs, and these descriptions, it is to be hoped, will serve as a sufficient guide for anything else that the amateur may desire to do in this way.

The hipped-roof.

1335. Let us suppose, first of all, that, instead of a roof sloping on *two* sides for a lean-to house, the amateur desires to make his roof

in *three* parts, so as to slope down to a gutter surrounding the three walls of the building, of which two are brought out at right angles to the original wall that forms the back of the structure, while the third forms the front. On consideration it will be clear that when a lean-to roof was used to such a structure as this, the front wall was level along the top, and the end walls, so to speak, were half-gabled or sloped upwards from the front wall. When a span-roof was adopted the side walls were level at the top, and the front wall assumed the form of a gable end, but now a hipped-roof is to be constructed, the three walls must be level and of the same height.

General form of hipped-roof.

1336. To form such a roof as this it is manifest that the first thing to be done is to fix a ridge-pole A B, as in figs. 648 and 649, projecting

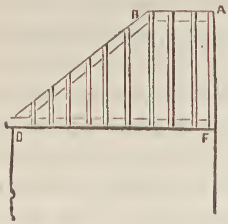


FIG. 649. HIPPED-ROOF. SIDE ELEVATION.

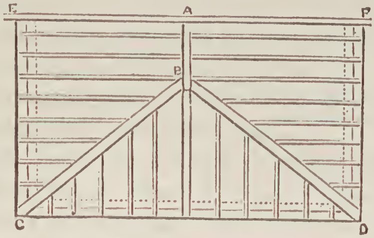


FIG. 648. HIPPED-ROOF—PLAN.

from the wall at the back. In fig. 648 the plan of the roof is shown, and the appearance presented by either side when viewed from the side is exhibited in fig. 649, although strictly speaking this is the elevation of the side of the building to the left hand. The ridge-pole being fixed and levelled hip-rafters C B and D B are placed in position, one end resting on the corners of the wall-plates where they join, and the other butting against the end B of the ridge-pole. These rafters may be about 4in. by 3in., if the roof is not very large and heavy. This being done, straight rafters of the same scantling as the hip-rafters must be placed along the wall-plates E C and F D and fastened, the first four on either side to the ridge-pole, and the remainder to the hip-rafters, the lower end of each being notched over the wall-plate. It will be noticed that these rafters, which are called jack-rafters, decrease gradually in length, until the last that is required is very short indeed, perhaps no more than 18in. or 2ft. in length. Rafters must be laid on in the same manner in front, the upper end of the central rafter butting against the ridge-pole and the rest against the hip-rafters, decreasing on either side until the whole

How to construct hipped-roof.

Ridge-pole and hip-rafters.

Jack-rafters.

are put in position. It will be manifest on consideration that the edges of the hip-rafters will have to be reduced with the plane a little on both sides so as to bring each side on a level with the upper surface of the upper rafters. A roof of this kind may be covered over in the same manner as lean-to and span-roofs, but if boarding is used care should be taken to cut the boards in such a manner that they may join accurately. The slanting lines of junction between the faces of the roof directly over the hip-rafters may be finished with rounded capping to conceal and protect the joint; but capping in this position should be left plain at the top, and not finished with a crest-board, as in the case of a cap surmounting the ridge-pole.

Reduction of edges of hip-rafters.

Capping to finish roof.

1337. The formation of the hipped-roof which we have been considering may be extended in the opposite direction, so as to form a roof with four sloping faces over four walls of the same height. We have now to look at another kind of formation, such as that presented by the roof of a gable end or attic window, projecting from the main roof. In this case the top of the walls will no longer be level, but will each be sloped upwards into gables or half-gables according to circumstances. We will, as before, imagine our roof to be placed over a building that forms a projection or offset from another, the wall of the old building forming the back wall of the new structure. As in the previous case, the principle involved can be extended to an independent building with gables at every face, if it be so desired, as will easily appear from the description about to be given.

Extension of general principle.

1338. Fig. 650 represents the plan, and fig. 651 the elevation when

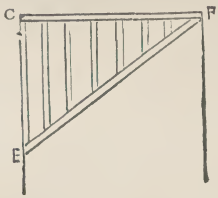


FIG. 651. GABLE ROOF—SIDE ELEVATION.

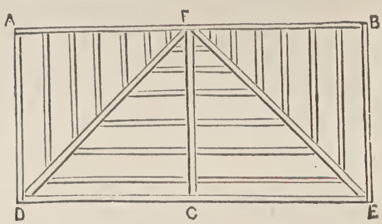


FIG. 650. GABLE ROOF—PLAN

viewed from the left-hand side, of such a roof as is now under consideration. A, B, and C indicate the highest points of the walls to be covered in, A and B being the summits of the half-gables, and C that of the entire gable in the front. Wall-plates are laid down the slopes of the walls from A and C to D, and

Method of construction of gable roof.

from B and C to E. A long horizontal timber is fixed against the wall forming the back of the new structure from A to B, and from its central point F a ridge-pole is laid to C. This being done hip-rafters are laid from F to D and from F to E. In the elevation, fig. 651, the points B, F, A, become merged, as it were, into one, and the middle point F has therefore been denoted by the same letter as in fig. 650, in order to distinguish the ridge-pole in each figure more clearly and to afford better means of identifying it in each. The next step in the process of construction is to add the rafters, sloping from the horizontal timber A F B to the hip-rafters F D and F E, and then the rafters from the ridge-pole F C to the other side of the hip-rafters. Thus there are four faces, similar in shape and size in fig. 650, but not necessarily so in practice, two of which slope from the highest parts of the whole roof to the hip-rafter F D, and two to the hip-rafter F E. The water, therefore, that falls on the roof will trickle downwards to the lines of the hip-rafters on either side and leave the roof at the corners D and E, where suitable provision must be made to carry it off. A roof of this kind, like the others already described, may be finished with a variety of materials, but the best and safest mode is to lay a piece of flat board down the line of the hip-rafters to form the bottom of a gutter, and then to cover the rest of the rafters with horizontal boarding. Sheet lead should then be laid in the valley thus formed, to receive the water, and the rest of the boarding covered with slates. The ridge F C must be capped with ridge-tiles, and the line A F B, with a flushing of lead or zinc let into the face of the wall behind and properly secured.

Wall-plates and hip-rafters.

Ridge-pole and rafters.

Guttering.

1339. Having considered the various forms which the roof assumes and the mode in which the necessary frame-work of wood is constructed in each case to afford a support for the covering material, we must now turn our attention to the covering material itself. This may be either natural or manufactured. Chief among the natural products with which a roof may be covered in are straw and reed, slate and wood, while among the manufactured articles the most important are tiles, cement slabs, roofing-felt and pasteboard, and sheets of zinc and corrugated iron.

Covering materials for roofs.

1340. With straw and reed the amateur will do nothing: the art of the thatcher is one that is very difficult to acquire, and while, especially in the western counties, many a farm labourer is to be found who can turn his hand to work of almost any kind, it will be found that he cannot, and will not, meddle

Thatching with straw or reed.

with the thatcher's work. Thatching is a special trade requiring much manual skill that is only to be acquired by practice, and in harvest-time in the West country a good thatcher is constantly in request on one farm or another, and earns good wages.

1341. In Devonshire the straw of wheat, when the leaves have been taken off by a rough comb, is bound in small bundles called *niches*, and termed "reed." The word straw is confined to barley and oat straw. In thatching, the lower end of the wheat straw is brought outwards and the head laid inwards, and when finished—that is to say, for barns and cottages, but not for ricks of hay or corn—the surface is shaved over with a sharp sickle. The long strong reeds growing in the marshes, and especially in Slapton Lea—hence called lea-reeds, or, as a Devonshire man would say, "lay-reeds"—are cut at a certain time of the year and stacked in bundles for thatching houses.

How thatching is done.

1342. It is useful for the amateur to prepare wheat straw in this way for the purpose of making mats to protect cold pits and frames and glass structures in winter. The mode of doing this will be seen from fig. 652. Two or three pieces of strong string, of some length, having been doubled so as to form two long ends, straw sufficient to make a layer from 1in. to 1½in. in diameter is thrust against the pieces of string where they are doubled, and the ends are pulled one in one direction and the other in another, so as to bind the straw tightly together. Another small bundle of straw is placed between the ends of string close to the first bundle and the strings are again crossed. The operation is continued until a mat of sufficient length is formed. When used the straw should be in the direction of the slope of the frame or pit, and as the mats will be comparatively narrow, and one will not be sufficient, in all probability, to cover the frame, two or three must be used, the one that is above the bottom mat and next to it lapping over it just as slates lap one over the other.

Mats of wheat straw.

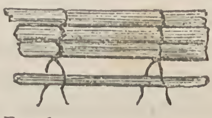


FIG. 652. MAT OF WHEAT STRAW.

1343. To return, however, to materials used for roofing, enough has been said about boarding over roofs with weather boarding or vertical boards to render necessary any further allusion to this material and the mode of using it. Cement slabs have also been spoken of in building with this patent material, and the mode of dealing with them has been fully explained. We have therefore only to consider the modes adopted for covering roofs with slates, tiles, roofing-felt and pasteboard and sheet metals, flat and

Materials for roofing not yet considered.

furrowed, or "corrugated," as it is technically called; but as the making of zinc and metal roofs belongs to the smith and zinc-worker, it will be better to leave the notice of them for that part of the book in which these trades are brought briefly under the consideration of the amateur-artisan.

Roofing with slates and tiles.

1344. The methods adopted in covering roofs with slates and tiles are very nearly identical. The tile is hung by a peg, or two pegs, on a lath nailed horizontally to the rafters and called a pantile lath: the slate may be hung on a lath in the same manner, or nailed on to horizontal boarding previously nailed down to the rafters to receive them. In all roofing operations, whether the material used be tiles, slates, pieces of wood cut in the form of slates or tiles, and in ornamental figures, such as triangles, semicircles, etc., the chief points to be regarded are that in all places all over the roof there shall be a *double thickness* of the material used, and that bond shall be properly broken, that is to say, that the line of junction between any two slates or tiles shall meet on and over the centre of a solid slate or tile in the course immediately below, so that no water shall make its way through the roof and into the building below during a fall of rain, however long or continuous it may be. It will be understood that the foregoing remarks apply to *plain tiles* or flat tiles, and not to *pantiles*, which form a ridge and furrow roof and overlap each other in a far less degree.

Laths for slates and tiles.

1345. The following memoranda with regard to slating and tiling will be useful, and first, with regard to the laths on which tiles are hung, let it be noted that a plain tile lath is 1¼in. wide and ¼in. thick, while a pantile lath is 1½in. wide and 1in. thick. A bundle of pantile laths consists of 10 laths 12ft. long, or 120ft. of lathing. A bundle of plain tile laths contains 100 when the laths are 5ft. long, 125 when they are 4ft. long, and 166 when they are 3ft. long; in fact, 500ft. of lathing in this form constitutes a bundle, whatever may be the length of the laths. One bundle of laths is used for tiling a square of 100ft. superficial.

Dimensions, etc., of tiles.

1346. With regard to tiles, a plain tile is about 11in. long, 7in. wide, and ⅝in. thick, and weighs about 2lbs. 5oz., or 2⅓lbs.; a pantile is 13½in. long, 9½in. wide, and ½in. thick, and weighs 5¼lbs. The number of tiles required for 100ft. super. of tiling varies according to the gauge used; thus, 600 plain tiles will be required for 4in. gauge, 700 for 3½in. gauge, and 800 for 3in. gauge. The wider the gauge, therefore, the fewer the tiles required, and the more economical the roof. For a square

Gauge for tiling.

covered with pantiles, 180 are required for 10in. gauge, 164 for 11in., and 150 for 12in.

Measurement of slating.

1347. Slating is also measured by the square, an allowance of 1ft. being generally made for the eaves. An allowance of 6in. is made on each side for cutting to hips and valleys, and when the slates are trimmed or cut at the bottom to present ornamental courses on a roof, at least one-third extra must be allowed. The most durable slates are those from the Welsh quarries. Ordinary slating, if not done with wooden pegs, is put on with iron or zinc nails, but iron nails will rust, and the heads of zinc nails often fly off when struck with the hammer, zinc being a very brittle metal. Copper nails are better than either zinc or iron, being far more durable, but, at the same time, more expensive.

Calculation of number of slates for roof.

1348. To find how many slates are wanted for a piece of roofing, multiply the length by the breadth, allowing for the row of slates below at the bottom and how much the rows of slates (or tiles) are laid one over the other. Of roofing slates, 120 are reckoned to the hundred.

Names and sizes of slates.

1349. Slates are known in the building trade by different names, according to their sizes, as shown in the following table, which exhibits the size of each kind, the gauge that is most commonly used first, the number required for a square according to the gauge specified, and the weight per thousand (that is to say, 1,200) in the first and second qualities.

Name of Slate.	*Size.*	*Gauge.*	*No. of Sqrs. covered by 1,200.*	*No. required to Square.*	*Weight per Thousand (1,200). 1st Quality.*	*2nd Quality*
Doubles No. 1. ...	12in. × 8in. ...	$4\frac{1}{2}$in. ...	2.8 ...	430 ...	$17\frac{1}{2}$cwt. ...	21cwt.
,, No. 2. ...	13 ,, × 6 ,, ...	5 ,, ...	2.5 ...	480 ...	15 ,, ...	18 ,,
Ladies No. 1. ...	14 ,, × 12 ,, ...	$5\frac{1}{2}$,, ...	5 ...	240 ...	31 ,, ...	42 ,,
,, No. 2. ...	15 ,, × 8 ,, ...	6 ,, ...	4 ...	300 ...	25 ,, ...	33 ,,
Viscountesses ...	18 ,, × 10 ,, ...	$7\frac{1}{2}$,, ...	6 ...	200 ...	34 ,, ...	$44\frac{1}{2}$,,
Countesses ...	20 ,, × 10 ,, ...	$8\frac{1}{2}$,, ...	7 ...	171 ...	40 ,, ...	50 ,,
Marchionesses ...	22 ,, × 12 ,, ...	$9\frac{1}{2}$,, ...	9.3 ...	130 ...	52 ,, ...	66 ,,
Duchesses ...	24 ,, × 12 ,, ...	$10\frac{1}{2}$,, ...	10.5 ...	125 ...	60 ,, ...	77 ,,

Larger kinds of slates.

1350. Other sizes of slates are known as Queens, Imperials, and Rags, but of these there are no absolutely determined sizes, and therefore no accurate data can be given as with the sizes above. Queens and Imperials are usually cut from 27in. to 36in. in length, but of irregular widths. Rags are of various lengths and widths. Of these kinds of slates a ton will cover from two to two and a half squares. For fixing slates, as many nails are allowed per square as there are slates, for all sizes from Doubles No. 1 to Viscountesses inclusive, but for the larger sizes two nails per slate are allowed.

1351. The framing of the roof being ready, and the slates delivered

Preparing roof for slates.

on the ground, the next thing to be done is to nail the laths across the rafters on which to hang the slates, unless the framing has been boarded over to receive them, and to pierce and peg the slates ready for hanging. In order that the laths may be laid at a proper distance apart, it is necessary first of all to decide on the gauge, that is to say, the width, from the bottom of the slate to the line across the slate in which the holes for pegs are to be made, or through which the nails that pin the slates to the boards are to be driven.

Setting out roof for laths.

1352. Let us see, then, how to determine where this line shall be drawn across the slate, and how to set out the roof for the laths. Suppose that the amateur is going to use Ladies No. 2, a slate which measures 15in. in length by 8in. in width. It is necessary for half the slate in the course above to lap over half two adjoining slates in the course below, to preserve all the requisites for a sound weather-tight, and to allow of proper breaking of bond. He will remember that the width of a plain tile lath, or a lath used for slating, is 1¼ in., and as half the length of his slate is 7½in. the width of his gauge must be 7½in. + 1¼in., or 8¾in., as shown in fig. 653, which represents a slate 15in. × 8in. drawn to scale. To make the gauge by which the dotted line C D may be scratched across each slate, a piece of lath must be taken and two nails inserted in it at the distance A B = 8¾in. apart. This being done, if one nail be drawn along the bottom of the slate, the other will trace the line C D. To prepare the slates for hanging on the laths a tool is used, called a slater's saxe or chopper, evidently derived from the *seaxe* or short sword of the Saxons, having a sharp point projecting from the back, as shown in the illustration. The cutting part of the blade is used for dividing slates, and the point for piercing a single hole at A in fig. 653, or two holes, about ¾in. from each side, as those shown near C and D. One or two pegs are used, according to the number of holes, the pegs being from 1½in. to 2in. long, and driven in home to the top so that there may be no projecting piece left, which would have the effect of lifting the slate that might lay next above and upon it.

Gauging and preparing slates.

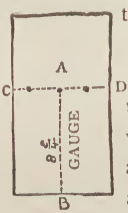


FIG. 653. PREPARING SLATE FOR ROOF.

FIG. 654. SLATER'S SAXE.

Slater's saxe or chopper.

Pegging slates.

1353. To set out the roof for the laths the operator must place his rule on the end rafters, so that the end may be 2in. or 3in. over the

eaves, as may be required to give the necessary drip, and make a mark on the rafter 14½in. from the end, and then 6¼in. below and 6¼in. above, continuing the marks upwards until the ridge of the roof is reached. This must be done, as it has been said, on each of the end rafters, and the marks must then be struck on the rafters intervening by means of a chalk line stretched across from end rafter to end rafter. Laths must then be nailed along the lines thus made, the top of the lath in every case being brought against the line; thus, in other words, the lath will be brought against the line, touching it, but will lie below it. This description will be better understood by referring to fig. 597 in page 562. In putting on the slates it will be found that the slates at each end of every other course will be of half width, as shown in the illustration, and the first row of slates along the eaves will have to be cut off along the line of the gauge. The same method must be adopted for plain tiles.

Process of setting out roof.

1354. All this must be done of necessity, but before the slates are put on there are other things that must be seen to as well. The rafters will, or ought to, hang over the wall, and to the ends of the rafters a facia should be nailed, to which the guttering may be attached. This facia-board should be made of substantial stuff, varying from 1in. to 1½in. in thickness, according to the size of the building. The depth of the facia will depend upon the size of the rafters, but it will seldom, if ever, be less than 6in. in width. Provision must also be made to give the first course of slates the proper inclination.

Facia along ends of rafters.

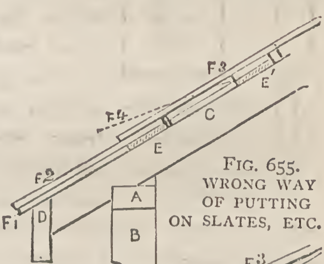


FIG. 655. WRONG WAY OF PUTTING ON SLATES, ETC.

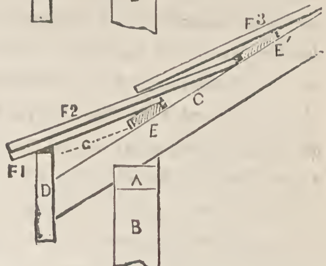


FIG. 656. RIGHT WAY OF PUTTING ON SLATES, ETC.

1355. What is meant by giving the proper inclination to the first course of slates will appear more clearly from figs. 655 and 656, which show, the first, the wrong way, and the second, the right way, of commencing to cover a roof with slates or tiles. In both these figures A is the wall-plate on the top of the wall B, C the rafter, D the facia destined to carry the guttering, and E, E', laths nailed lengthwise across the rafters to

Inclination of first course of slates.

sustain the roofing material. Now, if the first half course of slates were put on below the lath E, and in such a manner that the upper surface of the slate F 1 were parallel to the upper surface of the rafter, and the next course of whole slates F 2 were put upon it, it is plain that the upper part of the slate in question would be also parallel to the slope of the rafter, and that a space would intervene between the upper part of the rafter and the lower surface of the slate. This would have the effect of raising every course of slates further above the line of the rafters than that below it, and before many courses of slates had been put in position the pegs would fail to catch and be sustained by the laths; or, supposing that the upper end of the slate were pressed down so that the peg might catch on the lath, the lower portion of F 3 would be raised above the surface of the slate below it, and project in the manner indicated by the dotted line F 4. In a roof covered in this way there would be neither stability nor capability of resistance to the weather. It is necessary, therefore, to seek means by which the inconvenience and error already described may be avoided, and a proper inclination given to the first course of slates or tiles.

Example of wrong method of slating.

1356. To do this effectually and in a proper manner a piece of wood, such as is shown in section in fig. 656 at G, must be nailed to the rafters, of such a shape as to throw the outer edge or bottom of the slate or tile upwards; or, what is all the same, the rafters must be blocked at the ends with pieces shaped like G, or having, in other words, a wedge-like form and a strip of board nailed on these from end rafter to end rafter to carry the first half course of slates. The first half course will then take the proper position indicated by F 1 in fig. 656, and the first whole course, hooked on with pegs to the lath E, will lay flat on the half course as shown by F 2, while F 3 will indicate the position of the slates in the second whole course, and the manner in which every course of slate in a slate roof, and every course of tile in a tile roof, rests on the slate or tile immediately below it, as the case may be. Of course the relative position of the slates, and the space between them, has been somewhat exaggerated in the illustration, but this has been done purposely, the better to explain the proper way of going to work as clearly and definitely as possible. The facia D will have to be raised sufficiently high to cover the ends of the rafters and the ends of the pieces nailed on them.

Example of right method.

Facia must be raised above ends of rafters.

1357. We will pass on now to the last kind of material that will require mention here, and this includes the roofing-felt and the

asphalte roofing pasteboard. The roofing-felt is a strong, coarse, felted material made of hair, and apparently all kinds of hair-like refuse that will mat together under pressure, rendered water-proof by being saturated with tar. It is dirty to handle, and not very easy to cut, but when nailed over boarding and tarred and sanded it affords a durable roof impervious to weather. Of course all roofing-felt of this kind requires dressing with tar and sand once a year to preserve it. When left exposed to the sun and rain for some time without dressing, the tar with which it was saturated at making loses its power, and the felt gets broken up. This kind of roofing material, which is generally known as "Croggon's Patent Roofing-felt," is sold by most ironmongers and oilmen. It is sold in rolls 2ft. 8in. wide at the rate of 1d. per foot super.; thus the cost of every yard of the material per lineal measure is 8d. It is laid over the boarding of the roof in horizontal slips from side to side of the roof, and secured in its position by flat-headed nails; the lowest strip must be laid first, and then the one immediately above it, which must lap over the lowest slip to the extent of 2in. or 3in. Zinc or copper nails are better for nailing felt to wood than iron nails.

Roofing-felt.

1358. A better material, however, than the foregoing, more cleanly and comfortable to handle, and more easily cut, exists in the Anglo-Danish Patent Asphalte Roofing Pasteboard, for which the sole agents in the United Kingdom are MESSRS. H. ATKINSON AND CO., *Timber Merchants*, 33, *Wharf Road, City Road, London, N.* It was invented some years ago, and manufactured and used in Copenhagen by Messrs. Julius Erichsen and Co. for roofing purposes. But it was not introduced into England until 1870, when its fire-resisting capabilities were put to a severe test on the premises of the Patent Concrete Stone Company (Messrs. Ransome and Co.), East Greenwich.

Anglo-Danish Patent Asphalte Roofing Pasteboard.

1359. This material satisfies all the requirements of a substantial roofing: it resists the influence of water, fire, wind, heat, and cold better than other preparations that are somewhat akin to it in character, and is, moreover, cheap and easily obtained. Its cheapness is considerably increased by its lightness, a roof covered with it being at the utmost only one-third the weight of a tiled roof; consequently the frame-work to support it need not be so substantially made as for heavier roofs. Such roofs, moreover, require only a slight slope, say about 1½in. per running foot, which also tends to effect a saving in roofing material and timber when the roof is large.

Good qualities of this material.

1360. It may be well to observe, that the Royal General Insurance Company insure goods in buildings covered in with the asphalte pasteboard at the premiums fixed for buildings with fire-proof roofs. The result is that roofing with this material secures the lowest insurance premiums. It is, moreover, very durable, and when once made—provided always it be made in a proper manner—requires no repair for many years. As the pasteboard is a non-conductor, buildings covered with it are warm in winter and pleasantly cool in summer. It is sold in rolls 2ft. 9in. wide and 25ft. long, having a superficial content of 7½ square yards, at 5s. 7½d. per roll, which is at the rate of 1d. per square foot. When laid the material requires dressing with an asphalte composition called Erichsen's Patent India Mastic, which is sold at 9s. 9d. per cwt. in casks. The casks are included in the price, and it is said that 1 cwt. of the varnish is enough to cover a surface of 65 square yards. Nails of iron wire, specially constructed for fastening down the pasteboard, are supplied by Messrs. Atkinson and Co. at 1s. 1d. per 1,000, this quantity being enough for nailing down 15 square yards.

Buildings covered with this material insured at low premiums.

Price of material.

Erichsen's Patent India Mastic.

1361. The method to be adopted in roofing with the asphalte roofing pasteboard is as follows:—In the first place, the frame-work of the roof is to be covered in with dry boards—if well seasoned so much the better—from ¾in. to 1in. thick, and if convenient, not above 6in. broad. If they do not happen to be sufficiently dry, they should be split lengthwise before being laid down in order to keep them from warping, and every board should be fastened with three nails at least to each of the rafters. This splitting prevents the shrinking of the sub-structure from exercising any injurious influence on the pasteboard roofing. The boards do not require to be rebated, but the ends of the boards, which form the eaves, extending beyond the wall, ought to be joined in the best manner. When boards ¾in. thick are used, the rafters should not be more than 2ft. from each other, otherwise the boards may be too ready to give under the weight of the workmen engaged in covering the roof, while the roof itself will not be perfectly substantial. If, however, it is impossible to maintain the distance of 2ft. between the rafters, a greater distance—not exceeding four feet between each two rafters—being necessary, a thicker board or slip of wood should be fastened between the rafters from the eaves to the ridge, thus giving the sub-structure thorough firmness. If the edges of the boards be uneven, one side being broader than the

Method adopted in preparing roof.

Distance between rafters.

other, the narrower side should be laid downwards. The laths or slips between the rafters may be 1½in. wide and 1¼in. to 1½in. thick.

1362. As a roof constructed with asphalte pasteboard is entirely air-tight, provision should be made for ventilation in the form of air-tubes, like little bell turrets, about 3ft. square, rising from the roof, and fitted on all sides with diagonal louvre boards. If windows are used in the roof, these should be constructed in the same manner as those used for slated roofs. Gutters for the water to run off the pasteboard roof may be most easily arranged by fastening two laths on the roof after it has been covered with pasteboard, but before it has been coated with asphalte. These laths are then coated at the same time as the roof. This will be better understood on reference to fig. 657. If laths be nailed on the roof in the position indicated by A, B, C, and D, all the water that falls on the roof, or at least all that falls on it with the exception of that which is received on the triangular piece G, will be diverted to the corners E and F, at which provision must be made to conduct it to the ground or into some receptacle.

Ventilators in roof.

Construction of gutters.

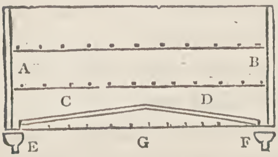


FIG. 657. ARRANGEMENT FOR THROWING WATER TO CORNERS OF ROOF.

1363. Roofing with rolls may be done either from gable to gable, horizontally, or from eaves to roof-ridge, vertically. The first roll is to be laid either at the gable (if vertical) or at the eaves (if horizontal), with a bend of 1in. beyond the roof, and be fastened down with the flat-headed 1in. or 1¼in. nails of iron wire, specially supplied for the purpose. The nails should be driven in 1in. apart. This being done, the second roll is laid with a lap of 1in. or 1½in. over the first, and both layers are fastened down simultaneously with one row of nails. Layer after layer is laid till the roof is complete.

Disposition of rolls of pasteboard.

Driving in nails.

1364. The covering of a double or span-roof is, of course, to be commenced on both sides from the eaves, and when the ridge has been reached from the first side the pasteboard is to be bent a little over to the opposite side and fastened there with nails, and when the other side has been covered, the pasteboard is to be bent over on the side first covered, so that it will be of double thickness just along the ridge. If a nail happens to come into a crevice between two boards and thus be not firm, another nail must be applied close by, and in such a manner that the head of the second nail partly covers the first. So that the first

Covering of span-roof.

Nail in crevice.

nail, although it was loose, may be fastened by the other and not rise, which would produce a small hole. The joints and heads of the nails are afterwards to be coated with the same asphalte mastic that is to be subsequently used in coating the roof. This is to be applied with a brush, and the mastic must, in case of the weather being cold, be previously heated in an iron pot, in order to render it fluid, but in hot weather it will be sufficiently fluid. The seams being thus coated over are to be strewn with dry sand, free from clay. This being done, and the asphalte mastic having sufficiently hardened, the superfluous sand is to be swept away, and the *whole* surface is then to be coated with the asphalte mastic, and strewn over by another workman, as the work proceeds, with dry sifted coarse sand. This sanding must be done as quickly as possible before the asphalte mastic has time to harden. In fact, when two men are employed, as soon as one has coated a space of from 20 to 30 square feet, the other should directly sand this piece over in such a manner that the surface everywhere is covered with it. This may best be done with a long rough-haired broom.

Application of asphalte mastic.

Sanding the roof.

1365. The workman occupied with the sanding has, at the same time, if required, to heat the asphalte mastic, and to bring it upon the roof in order that the man coating it may constantly go on working, and the work thus proceed as speedily as possible. Two workmen can, when the roof is not too high and steep, in one day coat nearly 500 square yards. It is, however, to be observed that the coating with asphalte mastic should only be done when the roof is dry, and in dry weather.

Roof should be finished in dry weather.

1366. To make the roof durable and perfectly water-tight for many years the coating is to be repeated once annually for the first two years, of course in dry weather; and every owner of such a roof may then, if these directions be attended to, rest satisfied that no further coating will be required for the next six or eight years. The fact is that the roof obtains an outer coating or crust, varying from ⅓in. to ½in. in thickness, which defies all the influence of the weather. When the roof has been covered with asphalte it may, if desired, be spread over with lime, chalk, or plaster of Paris, or any colour may be given to it to suit the taste. A white roof is especially to be recommended for buildings used for storing up goods which cannot bear heat, and whenever coolness is a desideratum.

To render roof durable and water-tight.

CHAPTER VII.

PLASTERING IN ALL ITS VARIOUS BRANCHES.

Plasterer's Work within Doors—Plasterer's Work outside the House—Materials and Tools used by Plasterer—Plaster: how classified—Coarse Stuff—Fine Stuff—Gauged Stuff—Proportions of Materials used—Influence of Thickness of Coating on Cement used—Hod of Plaster—Bundle of Laths—Whitewashing—Prepared Whitening for Whitewash—The Plasterer's Tools—Hammer—Trowel or Darby—Mortar-board or Hawk—The Float—The Plasterer's Brush—Cements, Templates, etc.—Lathing to receive Plaster—Distance between Laths—First Coat of Plaster, etc.—The Finishing Coat—Hardening of Coats—Test of Cements—Parian Cement: its advantages—Martin's Cement—Directions for using it—For Walls—For Painting—For Papering—For Floorings—For Lath Work—For Polished Work—To prevent Stains, etc.—How to Plaster Ceiling—Making a Cornice—Fine Stuff or Gauged Stuff to be used—Colouring Cornices—Roses for Ceilings—Plastering Outer Walls—Rough-cast: how it is done—Stucco for Concrete Wall—Mode of Procedure in Rough-casting—Panelled Walls—Disadvantage of Rough-casting—Stucco on Earth Wall—Stucco for External Work—How to make Strong and Durable Stucco—Reveals, etc., in Stucco—Plastering, etc., that Amateur will do—Repairing injury to Stucco without the House—Repairing internal Plastering—Mode of Procedure—Stucco Damaged by Blow—Whitening Ceilings, etc.—Protection for Clothing—Washing Dirt from Wall or Ceiling—Preparation of Whitewash—Another Method—To make Brilliant White Stucco—Coloured Washes: their utility—Relief in Stencilling—Æsthetic Paper-stainers, etc.—How to make Coloured Washes—How to Decide on Depth of Tint—Coloured Washes of Various Kinds—Warm Tints, etc.—Colour for External Walls—Mixing and Applying Washes—Method to be observed—Materials: where procured.

Plasterer's work within doors.

1367. THE plasterer's work lies both within and without the house, but it is in the interior that his services are chiefly called into requisition. When the walls are complete as far as the bricklayer or stonemason is concerned, they are as rough inside as without, and the plasterer's business is to give the inner surface of the walls successive coatings of plaster in order to render them smooth, for the reception of paint in oil or distemper, or wall paper. He has also to make good the party walls within the house which divide one room from another, whether they be of brick nogging, or simple partitions of lath and plaster. He coats the ceilings with plaster, makes, or rather moulds, the cornices, and finally whitens the ceilings and colours such walls as are to be coloured with

a wash stained to the desired tint by the addition of a little colouring matter to limewash.

1368. Outside the house the duties of the plasterer lie in coating brick-work or stone-work with stucco, prepared with cement, which hardens into a solid sheet impervious to rain, and in covering external walls with rough cast. It may be as well to consider plasterer's work, first as relating to the inside of the house, in coating the walls and ceiling of a room with plaster, and putting up a cornice and any other enrichments that may be deemed necessary ; secondly, with regard to external work, such as covering the outer surface of walls with stucco or rough casting ; thirdly, with reference to repairs both within and without the house ; and, lastly, respecting the mode of whitening ceilings and colouring walls, and the method of preparing white and coloured washes.

Plasterer's work outside the house.

1369. But before entering into detail on these points it may be useful to consider the materials and tools used by the plasterer, and the extent to which a certain quantity of the various kinds of materials used will go. The information given on these heads is derived from Laxton's and Spon's useful "Price Books."

Materials and tools used by plasterer.

1370. The plaster used by plasterers is generally classified as "coarse stuff," "fine stuff," and "gauged stuff." These differ one from another in the materials used, their relative proportions, and the manner of preparing them.

Plaster : how classified.

1371. *Coarse stuff* is common lime mortar, with a small quantity of hair mixed with it in order to spread through it and bind it well together. The proportions in which the lime, sand, and hair may be mixed to form coarse stuff are, lime-paste, 6 parts ; sand, 12 or 13 parts ; hair, 1 part. The hair used is procured from the tan yard, where it has been scraped from the skins of animals, or consists of the sweepings of hairdressers' shops.

Coarse stuff.

1372. *Fine stuff* is lime paste slaked to a paste with a moderate quantity of water, and afterwards diluted to the consistency of cream. It is then allowed to stand until by evaporation it has hardened sufficiently for working. A little sand or plaster of Paris is then added to it, and thus tempered it is used as a finishing coat over the first coating of coarse stuff.

Fine stuff.

1373. *Gauged stuff* is only used when the finishing coating is required to harden very rapidly, and for cornices, etc. It is formed by adding 1 part of plaster of Paris to 3 or 4 parts of fine stuff. For finishing off repairs this preparation may be

Gauged stuff.

used with considerable advantage, but the amateur must remember that the addition of the plaster of Paris will cause the mixture to *set* or harden very rapidly, and that no more must be mixed at a time than the operator is able to use conveniently. Gauged work unfortunately will often crack.

Proportions of materials used.

1374. With regard to quantities of material used in plastering, it is estimated that 1 cubic yard of lime (chalk), 2 yards of road drift or sand, and 3 bushels of hair will cover 75 yards of *render and set* on brick, or 70 yards on lath. The same quantity will cover 65 yards *plaster or render*, two coats and set, on brick, or 60 yards on lath. Floated work will require about the same as two coats and set.

Influence of thickness of coating on cement used.

1375. The thickness of the coating of compo or stucco with which a wall is covered will of course influence the quantity of cement that is used in the operation. According to the thicknesses given, 1 bushel of cement used by itself or mixed with 1, 2, or 3 bushels of sand will cover superficial space as follows :—

Thickness......	½in. Yards.	¾in. Yards.	1in. Yards.
1 bushel of Cement...	2¼	1½	1⅐
1 ditto and 1 of Sand	4½	3	2¼
1 ditto and 2 of Sand	6¾	4½	3⅓
1 ditto and 3 of Sand	9	6	4½

It must be remembered that the cement is weakened by the addition of sand, and that if a strong and durable coating of stucco is required, it will be better to use equal proportions of sand and cement. A useful and sufficient thickness will be found in ¾in.

Hod of plaster.

1376. A *hod* of plaster is reckoned to be about ½ bushel ; 2 bushels of grey lime or 3 of blue lias are equal to 1 bag ; 20 bushels of sand go to 1 yard ; 3 bushels of cement make 1 sack ; and a cask of Portland cement contains 4 bushels ; 14 pounds of plaster of Paris constitutes 1 bag, and 7 bags make 1 bushel.

Bundle of laths.

1377. In addition to the above memoranda, which may prove useful in calculating quantities required and in buying, it may be desirable to remind the reader that a bundle of laths measures 500 feet per foot run, whatever may be the length of the laths, whether long or short. It is reckoned that 1 bundle of laths and 500 nails will cover about 4½ superficial yards. The single fir laths are about ¼in. thick, and often less than this ; the stouter or double laths are about ⅜in. thick.

1378. With regard to whitewashing to cover 100 square yards superficial once over, 12lbs. of whiting—to be bought of any oilman and at some grocers'—will be wanted, with ½lb. of blue-black and 1¾ gallons of size. To go twice over the same superficial extent: 21lbs. of whiting, ¾lbs. of blue-black, and 2¾ gallons of size will be required. A prepared whitening for whitewashing is now sold, the chief merit of which appears to be—and a great merit it certainly is—that in mixing it for use, no size need be added to it. All that is necessary is to add water to the whitening, and the whitewash is ready. It is made by MESSRS. GROVES AND CO., *Crown Road, Fulham, S.W.*

White-washing.

Prepared whitening for whitewash.

1379. The tools required by the plasterer are hammers, trowels, floats, and moulds, with brushes. Other tools than these are used by the regular plasterer, but these will be all that the amateur-artisan will want, as it is unlikely that he will try his hand at anything else than mere repairs, and this is by no means clean and pleasant work. The hammer used by the plasterer has a face for striking nails on one side, and an axe-shaped blade on the other, with a nick in it on the bottom of the blade. This blade is used for chopping and breaking laths to the proper length when necessary. The nails used for attaching laths to quartering of partitions, or joists of ceilings, are furnished with a head, and resemble, in some degree, small clasp-nails. For putting on coarse stuff the ordinary bricklayer's trowel may be used; but for laying on fine stuff, and smoothing the finishing surface of a wall, a trowel of peculiar form and make, with the handle springing from and parallel to the blade, like that shown in plan at A and in section at B in fig. 658, is required. It will be readily seen that plaster can be spread far more easily and smoothly with a trowel of this construction than with an ordinary trowel. This trowel is technically called a "darby," a corruption presumedly of *dauber*, an old English word applied to those who built walls of mud or clay mixed with straw, and to plasterers as well as to the tool with which the daubing or plastering was done. Primarily the word is derived from *dabble*, which means to work in wet materials.[1] The little square mortar-board on which

The plasterer's tools.

Hammer.

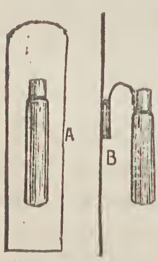


FIG. 658. PLASTERER'S DARBY.

Trowel or darby.

[1] The word "daub" has changed somewhat in its signification since the translation of our English Bible now in use was made. We do not speak of *daubing* a wall with mortar now. It is in the sense of covering with an external coating that

the plaster is held for the plasterer's use, and which has been de-

Mortar-board or hawk.

scribed in the chapter on bricklaying, is technically called a "hawk," though why it should be so no satisfactory reason appears. The float is a long straight-edge, higher in the

The float.

middle than at the ends, which is dipped in water and worked over the surface of the plaster in order to render the surface perfectly level. This name is also given to a wooden tool similar in shape to the darby, which is also dipped in water and worked over the plastering to produce a smooth and even surface.

1380. Lastly, the kind of brush chiefly used by the plasterer, whether for applying water to the surface of his work or for washing

The plasterer's brush.

the dirt off walls that are to be re-coloured, or ceilings that are to be whitened anew, is one of the shape indicated in fig. 659, being from 4in. to 6in. in width across the broad part of the handle, to which three tufts of long hair are fastened, as shown in the illustration, the whole spreading out into a broad, flat brush capable of holding a good deal of water or colouring matter, and of being worked over the surface of plaster without doing more than remove the external coating of dirt and colouring matter when the wall or ceiling is being cleaned. The price of such brushes as these varies from 2s. to 3s. No amateur artisan should be without one.

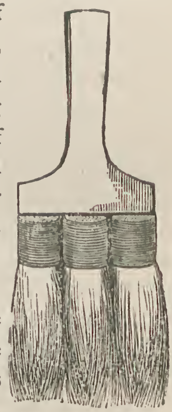


FIG. 659. PLASTERER'S BRUSH.

1381. Enough has now been said about the materials used by the plasterer and the tools that he employs; but further on some additional remarks

Cements, templates, etc.

may be made on cements in connection with plastering, and the templates or moulds with which cornices are fashioned. We must now go back to the order in which it was proposed to treat plasterer's work in section 1368, and consider it as relating to the inside of a house in coating walls and ceilings, afterwards touching briefly on the subsidiary work of putting up cornices and enrichments of ornamental work, such as roses, in the centre of a ceiling.

1382. First of all there must of necessity be some surface to which to apply the plaster. This exists, of course, in all brick and stone

Jochebed, the mother of Moses, is said, in Exodus ii. 3, to have "daubed" the ark of bulrushes, in when she exposed her infant, with slime and pitch; and, again, in Ezekiel xiii. 10–15 and xxii. 28, the prophets of Israel are likened to men *daubing* a wall with untempered mortar.

walls and brick nogging partitions in the rough surface that brick-work or stone-work presents, and to which plaster will readily cling; but in ceilings and ordinary partitions of framed timbers or quartering there is nothing of this kind, and an artificial surface must be created on which the plaster may be laid. This is effected by means of

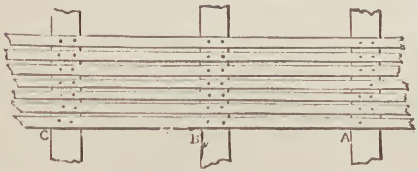


FIG. 660. LATHS NAILED TO QUARTERING OR JOISTS.

laths, which are nailed, as represented in fig. 660, to the timbers A, B, C, which may represent either the outer faces of quartering or the lower faces of the joists of a ceiling. It is unnecessary here to enter on the various modes of making a ceiling, or rather framing together the timbers of which it consists, as that is a process which belongs strictly to carpentry, and has been dealt with elsewhere.

Lathing to receive plaster.

1383. Whether it be for the formation of a ceiling or a partition, laths must be nailed all over the exposed timbers at distances which will vary from ¼in. to ½in., according to the configuration of the laths, as in the accompanying illustration. The interstices between the laths are highly useful, and render the surface far better for coating over with plaster than a smooth surface; for when the mortar is put over the laths part of it penetrates between them, and when hard keys, as it were, the plaster to the laths, and renders it difficult of removal. A lath and plaster partition between two rooms, or between a room and a passage with-

Distance between laths.

FIG. 661. SCORING FIRST COAT OF PLASTER.

out it, must be covered with laths, and plastered on both sides. As the first coat of plaster is spread it is scored over by means of the trowel with rough diagonal lines about ¼in. deep, as shown in fig. 661, and these rough and deep lines, which are made at a distance of about 2in. apart, serve to hold the second coat of plaster to the first in the same manner as the interstices between the laths gave material assistance in holding the first coat.

First coat of plaster, etc.

1384. Great care must be taken in reducing with the float the finishing coat, whether there be two or three, to a surface smooth and level in every part, as there are few things more unsatisfactory to the eye than an uneven wall, receding in some parts from, and projecting in others beyond, the true surface. Equal care, too, must be taken in finishing the arrises or edges of projecting

The finishing coat.

chimney-breasts, or of any recess in the wall where the two surfaces of the wall and the reveal meet at right angles. These—to borrow a term from fortification—are salient angles: the converse of these, namely, re-entering angles formed by the meeting of two sides of a room, or the reveal of a recess and the wall at the back, must be finished in the same careful, painstaking manner, otherwise the room will not look well when it is papered. Sometimes, to assist the plasterer in covering his walls with plaster, a strip of wood is nailed to the chimney-breast on either side, and occasionally in the angles of the rooms, and the plasterer is bound to govern his work by these strips of wood.

Hardening of coats.

1385. In plastering it is desirable that the work, from the first coat to the last, should harden as soon as possible; firstly, that the plasterer may proceed from one coat to another with as little delay as may be; and, secondly, that the plaster may be covered with paint or otherwise treated as soon as it is in a fit state to receive it. For this end various cements have been introduced in which some foreign ingredient is mingled with the usual materials, with the view of making the plaster set slowly enough to be manipulated with ease, and render it fit to be painted on at once as soon as it is set. For all practical purposes there is nothing better than Portland cement, but the cements known as Parian cement and Martin's cement have long been popular, the latter being said to have the advantage from its chemical composition of covering more surface in proportion to its bulk than any other similar material.

Test of cements.

1386. It is well remarked in "Laxton's Price Book" that "the test of these materials is, of course, the way in which they work." Some years ago, before these cements were so largely used as they are at present, all *making good*, as it is technically called—*i.e.*, patching up holes in old plastering—used to be done with *plaster*. Then Keene's was introduced, but the men did not like it; it was troublesome and uncertain, and, as they said, worked harsh. When Parian, however, came into play, they preferred it to the plaster, and always used it when they could, as it was sufficiently mild to be worked to advantage, and demanded no excess of labour. Most of these internal cements attain a very great degree of hardness, and they are capable of receiving a polish almost equal to marble; they are rubbed down with "grit-stones" of various qualities, a stopping being added—that is, plaster in a semi-fluid state—which fills up the pores; this is followed by the same process with "snake stone," and finally finished with putty powder. The chief advantage of Parian cement is that, from

the character of the material with which its base—plaster—is qualified, it will take paint almost immediately; indeed, the sooner it is painted the better. In workmen's phrase, the brush should follow the trowel, and this enables rooms of first-rate character to be finished ready for occupation at once, instead of having to wait a whole season for the plastering to dry. In additions and alterations, where expense is not of the first importance, this renders its use of great advantage.

Parian cement: its advantages.

1387. Martin's cement, when used for internal work, can be painted upon in a few hours, a great desideratum where rapidity of progress is absolutely necessary. It is to be mixed with clean water, and, when it has been well beaten up, it must be applied to walls like plaster or cement of an ordinary kind.

Martin's cement.

1388. The following directions for using Martin's cement, and for other operations in connection with it, are given in "Spon's Pocket-book of Prices":—

Directions for using it.

(1) "*For Walls.*—Use the coarse cement in the proportion of one measure of cement to one measure and a half of clean, dry, sharp sand for the under coat of half an inch thick, and finish one-eighth of an inch thick with pure cement.

For walls.

(2) "*For Painting.*—Once within twenty-four hours after completion; care should be taken that oil alone be employed for the first coat, adding a more than ordinary quantity of dryers for the second coat; two parts of oil to one of turps for the third coat; one part of oil to two of turps for the fourth and following coats at the discretion of the painter; but much will depend on the description of the work, the more the suction the more oil in proportion. Body colour should be avoided in the first coat. Three coats are generally sufficient.

For painting.

(3) "*For Papering.*—One coat of size is sufficient, and paint is not requisite.

For papering.

(4) "*For Floorings.*—Use an equal proportion of sand and cement, mixed stiff and well beaten down with a shovel to the thickness of three-fourths of an inch, on a solid foundation. Allow it to remain ten or twelve hours, and then float with half an inch of pure cement.

For floorings.

(5) "*For Lath Work.*—Zinc nails should be used.

For lath work.

(6) "*For Polished Work.*—Proceed as for walls, but finish with fine or superfine cement if a pure white is required. It should then be worked as marble, a stopping being applied where requisite till the desired face is obtained. Care should

For polished work.

be taken that a sufficient time be allowed for the surface to dry between every application of the stone or putty powder.

To prevent stains, etc.

(7) "*To prevent stains in the work* wood or zinc trowels are recommended. When iron tools are used they should be constantly cleaned in strong limewater; but when work is intended to be painted this precaution is unnecessary. Plaster of Paris should not be used or mixed with this cement, nor Portland used as an under coat." When put on half an inch in depth one cwt. of Martin's Patent Cement will cover twenty-eight superficial feet when used neat, or twice that area when mixed with an equal quantity of good sand. The cost of one cwt. of this cement in Derby is 4s. 3d., but in London 5s.

How to plaster ceiling.

1389. The process to be followed in plastering a ceiling is the same as that adopted for walls. First the laths must be nailed to the joists, then the first coat of coarse stuff must be spread over the laths and the surface marked with diagonal lines crossing one another; and, lastly, the work must be finished with one or two coats of fine stuff as may be deemed necessary. When perfectly dry it will be ready for whitening. If, however, a cornice is to be added round the top of the room, and a rose to be affixed to the centre of the ceiling, these jobs should be done before any attempt is made to whiten the ceiling, or to colour, paint, or paper the walls of the room.

Making a cornice.

1390. And, first, with regard to the cornice: if this is very large, and consequently too heavy to be made solid, it is usually cast in pieces and fixed in position. Otherwise a foundation may be made for the cornice by fixing blocks of wood, either triangular in form or approaching even more nearly to the outline of the cornice, and to these laths or slips of wood must be nailed, on which the first coat of coarse work must be spread. Thus the brackets which form the primary foundation of the cornice may be a simple triangle as in fig. 662, or cut into projecting angles and recesses as in fig 663; but, however this may be, the mode of procedure as regards the rest of the cornice is the same in either case; for laths are nailed, as shown in section in the illustrations, to the faces of the brackets, and on the

Fig. 662. Triangular bracket.

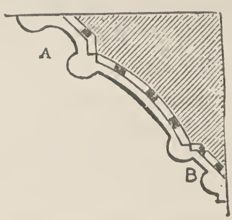


Fig. 663. Bracket cut in angles.

Foundations for cornices.

rough surface thus formed the plaster is spread. Cornices are generally formed in fine stuff or gauged stuff that they may set quickly, and a regular shape is given to them from end to end by means of a mould or template, which is cut out in wood and run along the surface of the plaster to bring it into the required form. Of course this need only be resorted to in the case of broad or massive cornices which are not cast before fixing in position. When the cornice is but small, and therefore of no great weight, the plaster may be run along the angle formed by the meeting of the planes of the ceiling and the walls of the room and moulded without the help of any foundation. If possible, as little width as can be conveniently arranged should be allowed at the top of projections such as occur at A in each of the above illustrations, because the dust will settle on any such projecting piece and form a dark line, which will detract from the general effect of the cornice. Cornices should be coloured in distemper with the prevailing tints in the wall paper, and the effect is considerably improved if the lower member of the cornice, as at B, be gilt or touched over with gold paint.

Fine stuff or gauged stuff to be used.

Colouring cornices.

1391. Unless the amateur is possessed of some skill as a modeller he is advised not to attempt a cornice in cast work. A rose in the centre of any ceiling is a great addition to the general appearance of a room. These were originally made in plaster, but may now be procured in papier maché of the PAPIER MACHÉ COMPANY (LIMITED), 21, *Wellington Street, Strand, London*, 2 feet in diameter, at 5s. each, plain, 10s. in white and gold, or 15s. finished in a very superior manner. They can be easily fixed to the timbers of the ceiling with screws; but it is possible that the disposition of the joists may be such that the rose will not fall exactly in the centre of the ceiling as it should do. When a house is building provision can be made for this by the insertion of cross-pieces between the joists.

Roses for ceilings.

1392. We must now pass on from internal work, namely, the coating of walls and ceilings with plaster, to the covering of the outer surface of walls. This is generally done by the application of rough-cast or a coating of stucco. The object is partly to obtain a surface impenetrable by moisture, and partly for the sake of giving a better appearance to the walls. The amateur will readily understand how necessary this is in the case of walls of beaten earth, which will present a rough and unattractive surface of a light brown colour. Similarly, walls of concrete built on the monolithic system

Plastering outer walls.

require an outer facing of stucco to fill up the crevices, and so conceal all blemishes and imperfections which are inseparable from this mode of building.

Rough-cast: how it is done.

1393. Rough-cast is made in this way. Some mortar is put in a shallow tub, and sufficient water is added to bring it to the consistency of cream; a little fresh lime is then added to it, and some very fine and small shingle mixed with it, if pebbles sufficiently small can be obtained. To give an idea of the proper size, the shingle may vary from that of a sweet pea seed to that of a garden pea or horse bean. Another mode of making rough-cast is to wash gravel or coarse sand until all the finer particles are carried away, and then mix the residue with fresh slacked lime and water until the mixture is of the consistency of cream. Rough-cast, however, looks better for the addition of a little shingle.

Stucco for concrete wall.

1394. A concrete wall should be covered with stucco rather than rough-cast, but if it be determined to rough-cast a wall of this description, all holes of any size should be stopped with cement or plaster before the operation is commenced. An earth wall should be chipped over with a slater's hammer, as the indentations thus produced will afford a better holding for rough-cast mixed with fine pebbles; and if the rough-cast be made of gravel, they will help in giving a rough and broken appearance to the surface strictly in accordance with the character of this kind of surface-coating.

Mode of procedure in rough-casting.

1395. When all is ready the workman must damp the surface of the wall with water, by dipping his large brush in a pail of water close to him, and then sprinkling what is held in the brush over the wall. This done, he takes up the rough-cast either with his brush, on a trowel, or in his hand, and throws it against the surface of the wall, to which it will adhere. Sometimes, in the case of brick or stone walls which are coated with rough-cast, a coating of lime mixed with hair—plaster, in fact—is first laid on, and before this is set the rough-cast is thrown against it. Occasionally small pebbles or coarse sand are thrown against the plaster, and when dry the surface is coloured with a wash of lime and sand. A good effect can be produced in rough-casting by dividing the surface of the wall into panels by means of thin strips of wood or iron rods, which must be fixed by nails. The framing of the panels can then be filled with cement, which should be brought to a smooth surface and painted, and the panels themselves filled with rough-cast. If the framing be coloured black or dark brown an

Panelled walls.

appearance is produced similar to that of the black and white houses of Cheshire, which are highly picturesque.

1396. The worst about rough-cast is, that it has a damp look whenever it rains until fine weather has set in once more and the surface has had time to dry; and this point may also be urged against stucco, which always looks damp in wet weather, though in reality it is not so. The only way to prevent this is by painting the exterior. This can be done with good effect with stucco when it has once got thoroughly dry, but not with rough-cast.

Disadvantage of rough casting.

1397. When an earth wall is to be covered with stucco it should be dented all over with blows from the sharp side of the slater's or mason's hammer, as recommended in preparing for rough-cast. Brick and stone walls, and walls of concrete will require no preparation of this kind. Stuccoes are of different kinds. Finer stuccoes, used for internal work, are made of lime or gypsum, sand, and marble reduced to powder. When it is desired to give such a composition a polished surface like marble, or to use it as an imitation of marble, glue or gum-water is mixed with it in order to fill all the pores, and, when perfectly hard, the work is rubbed down with pumice stone and polished in the same manner as marble.

Stucco on earth wall.

1398. Stucco for exterior work is made of cement or unslaked lime in the proportion of one part to six parts of clean sharp sand. As soon as the surface of the wall has been properly prepared for the reception of the stucco it is sprinkled with water, and the stucco laid on with a plastering trowel and worked smooth and level by the aid of a brush and float. Sometimes the surface of stucco is sprinkled with diluted mortar, or the wall is dressed with unslaked lime and water, which is applied to the wall before the stucco is dry. It is said that walls treated in this way will set very hard, and always preserve the clear white colour imparted to them by the limewash. Walls should be thoroughly dry before stucco is applied to them. Spots of damp will cause the plaster that covers them to rise and swell, and ultimately to crack and fall off, sadly disfiguring the wall. When cement is used the walls are not dressed with limewash, and the result is, that the face of the wall is of a dull greyish brown colour. Cement stucco will, however, take paint well, though a brush is soon worn down and worn out when worked over so rough a surface. The horizontal and perpendicular marks by which a stuccoed wall is divided into large blocks, giving it the appearance of being built of large stones, are made by means of a

Stucco for external work.

straight-edge, and, generally speaking, the loop of a key, which is commonly used by plasterers for drawing such lines.

1399. In Burn's "Handbook of the Mechanical Arts" it is said that a strong and durable stucco for the finishing of the outside of rough brick and stone walls may be prepared as follows:—

How to make strong and durable stucco.

"Take stone lime fresh from the kiln, and of the best quality, such as to make a strong and durable mortar. Slake it by sprinkling or pouring over it just water enough to leave it, when slaked, in the condition of a fine dry powder, and not a paste. Set up a ¼ in. wire screen at an inclined plane and throw this powder against it. What passes through is fit for use; that which remains behind contains the core, which would spoil the stucco, and must be rejected. Having obtained the sharpest sand to be had, and having washed it so that not a particle of the mud and dirt (which destroy the tenacity of most stuccoes) remains, and screened it to give some uniformity to the size, mix it with the lime in powder, in the proportion of *two parts* sand to *one part* lime. This is the best proportion of lime stucco. More lime would make a stronger stucco, but one by no means so hard—and hardness and tenacity are both needed. The mortar must now be made by adding water and working it thoroughly. On the tempering of the mortar greatly depends its tenacity. The wall to be stuccoed should first be prepared by clearing off all loose dirt, mortar, etc., with a stiff broom. Then apply the mortar in two coats: the first a rough coat to cover the inequalities of the wall, the second as a finishing coat. The latter, however, should be put on before the former is dry, and as soon, indeed, as the first coat is sufficiently firm to receive it. The whole should then be well floated, trowelled, and marked off, and if it is to be coloured in water colour the wash should be applied so as to set with the stucco."

Reveals, etc., in stucco.

1400. Stucco is frequently used for reveals to windows, and for making ornamental work projecting beyond the surface, such as string-courses and labels, drip-stones or hood mouldings over doors and windows.

Plastering, etc., that amateur will do.

1401. It may be naturally asked, what will the amateur be most likely to turn his hand to in the plastering line, and what use will any knowledge of the plasterer's art be to him? He will not, it is true, at any time attempt to stucco the side of his house, however much he may require it; but suppose he has built a greenhouse against an old brick wall, surely the brick-work that appears in the interior of the structure will be all the better, or at all events more pleasing to the eye, if it be hidden beneath a

coating of stucco. Again, it may be desirable to execute repairs either within or without the house, without sending for a plasterer or bricklayer; and it is in these minor points that a knowledge of how to make stucco and plaster, and how to apply these compositions, will be useful.

1402. Suppose, for example, that, by some accident, a large piece of stucco has been knocked off the outside of the house, or that the sharp clean edges of a stuccoed corner have been carried away by a garden roller that has been accidentally brought in contact with it. Suppose, again, that a water-pipe has burst within the house, and that some plaster, whether on wall or ceiling it matters not, has become saturated with water, burst away from the laths or bricks over which it had been placed, and compelled removal by reason of its insecurity. The water-pipe having been repaired, the first care of the amateur artisan should be to cut away the plaster all round the borders of the spot that has been injured by water, until he has got an inch or two beyond the limit to which the dampness has made its way. Time should then be given for the lath-work or brick-work to dry out thoroughly. If the lath-work has become broken or otherwise insecure, or if it has been cut away by the plumber to get at the pipes, it must of course be renewed. It must be borne in mind that new plastering or stucco work will never adhere to old work unless the old work be first wetted; so in every case, before putting up the new plaster, it will be needful to sprinkle the edges of the old work with a brush dipped in water. Then put up the first coating of rough plaster, and cross the surface with lines for the reception of the second coat, applying even a third coat, if it be necessary, as a finish. Finally, when the whole is dry it must be whitened, if it be part of a ceiling, or painted or papered if it be part of a wall. Directions for colouring with distemper washes or lime-wash will be given presently.

Repairing injury to stucco without the house.

Repairing internal plastering.

Mode of procedure.

1403. Similarly, when stucco or plaster has been damaged by a blow, all the loose stuff must be carefully cut away, until every atom of it has been removed and the surrounding parts are perfectly solid. The edges of the firm part must then be sprinkled with water, and the new plaster or stucco put on as directed above. Where the damage is but slight—as, for example, when a key has been left in the lock of a door, and the door when thrown open, by reason of its falling back against the wall, has caused the loop of the key to knock a hole in the plaster—the dust

Stucco damaged by blow.

should be carefully brushed away out of the hole, and the cavity slightly wetted and filled up with a little gypsum or plaster of Paris.

1404. Lastly, a few words are necessary respecting the method of whitening ceilings and colouring walls in distemper, both within and without the house. This is by no means a clean job, and the amateur will in all probability splash himself, the walls, and everything round about him, when he first attempts this kind of work. The great secret in whitewashing, or applying any wash, white or coloured, is to do the work quietly, slowly, and deliberately. Energy in such a proceeding is simply thrown away. It is necessary, too, that unless the amateur artisan has a dress expressly for every kind of work which involves dabbling with lime and mortar, he should have his cloth clothes protected from injury by a white canvas slop and overalls of the same material. It will also be well to wear a cap of linen or paper.

Whitening ceilings, etc.

Protection for clothing.

1405. When walls and ceilings are fresh from the hands of the plasterer, no preparation is required prior to whitewashing; but when either wall or ceiling has got dirty through dust and smoke, all the dirt must be washed off before any attempt is made to whiten or colour its surface. It will be as well to begin with a description of the washing process. The operator should stand on a strong table, or on scaffold-boards supported on trestles, so as to be within easy reach of the ceiling. Dipping his large brush in a pail of clean water, he should then draw it slowly backwards and forwards over the surface, pressing the hairs of the brush firmly against it, raising the brush frequently, and changing the water as often as it gets coloured by the dirt that comes away from wall or ceiling on the brush. Continue the washing until scarcely any soil is communicated to the water by the brush. When the dirt is completely removed, let all roughnesses be scraped down, and cracks carefully stopped with putty. The best thing that can be used to whiten or re-colour the walls and ceiling is undoubtedly limewash—that is to say, a wash made of lime; but under the influence of the air, and any emanation from sinks—that is to say, all foul gases—wash made with lime is apt to turn black, and although it has done its work as a purifier by neutralising the foul matter that is floating about, its whiteness has gone, and its former beautiful appearance is altogether lost. Another kind of mixture is therefore generally substituted for limewash, and this substitute is whiting, a pure white earth that is moulded at the place where it is prepared

Washing dirt from wall or ceiling.

into large irregular lumps, in which state it is kept and sold by oil and colourmen.

1406. There are different modes of preparing whitewash from whiting. One way is to place it in cold water over night, and allow it to soak till the morning, when the ingredients may be incorporated by stirring until a smooth cream-like mixture is produced. A little strong size should then be made, and mingled with the whitewash to the extent of ¼ pint of size to a gallon of whitewash. The presence of the size renders the wash a sort of distemper, and prevents the whitening from coming off when dry on anything that may be drawn against it in passing. It is generally supposed that whitewash prepared in this manner is durable, and will never rub off; but it depends altogether on the position of the walls that are coloured with it. No whitewash, however strongly it may be sized, will stand in a damp position, or where it is exposed in any way to the action of damp. Dampness in the air, technically speaking, *kills* the size, that is to say, deprives it of its binding power, and as soon as this is destroyed the whiting will come off on anything that comes in contact with it. Another method of making whitewash with whiting is to mix as many balls or lumps of whiting as may be required with as much water as may be needed to reduce it to a thick paste; about ½lb. of hot size may then be added for every lump of whiting that may be used, and with the size, which should be hot, a small quantity of blue-black should be thrown in, which, when incorporated with the mixture, makes it a "good colour," as it is called.

Preparation of whitewash.

1407. Another method of making whitewash, which is strongly recommended, is to take a barrel or other suitable cask, clean and water-tight, and put into it half a bushel of lime. Slake it by pouring water over it, boiling hot, and sufficient in quantity to cover the lime to the depth of five inches, and then stir the whole briskly until the lime is thoroughly slaked. When the slaking has been effected, add two pounds of sulphate of zinc dissolved in water, and one of common salt. These ingredients will cause the wash to harden and prevent it from cracking, which gives an unsightly appearance to the work.

Another method.

1408. In the "Handbook of the Mechanical Arts" the following is the recipe given for making the celebrated stucco whitewash used for the President of the United States' residence at Washington, a building which from its spotless whiteness has received the name of the "White House," and is usually spoken of as such. "Take half a bushel of good unslaked lime, slake

To make brilliant white stucco.

it with boiling water, covering it during the process to keep in the steam. Strain the liquor through a fine sieve or strainer, and add to it a peck of clean salt previously dissolved in warm water; three pounds of good rice, ground to a thin paste, and stirred in while boiling hot; half a pound of powdered Spanish whiting, and a pound of clean glue which has been previously dissolved by first soaking it well and then hanging it over a slow fire in a small kettle within a large one filled with water. Add five gallons of hot water to the mixture, stir it well, and let it stand a few days covered from dirt. It should be put on quite hot, for this purpose it can be kept in a kettle on a portable furnace. It is said that one pint of this mixture will cover a square yard upon the outside of a house if properly applied. It retains its brilliancy for years."

Coloured washes: their utility.

1409. Whitewash is all very well for the ceilings of basements, and all low out-of-the-way places, because it reflects the light, and by lighting up the room imparts more cheerfulness to its aspect, and renders it all the more fit as a habitation for human beings. For ceilings of lofty well-lighted rooms, however, whitewash is too bright and dazzling, even for the strongest sight, and it has been found advisable to subdue its brilliancy by the addition of a slight quantity of colouring matter, or to relieve the broad unvaried expanse of white by lines of colour in the cornice, and by a stencilled pattern in some light and pretty tint that is repeated in the paper, or which forms the ground-work of the walls. For example, a white or very pale blue ground, with a stencilled pattern in darker shades of blue, looks very cool, chaste, and pretty; while in a room fronting the north, or some other equally cold and dark quarter, a warm grey, enlivened with stencilling in crimson of different shades or Indian red, will look very well. The old fashion of stencilling walls has been revived to a great extent of late years, and it is to be hoped, will yet more and more supersede wall-papers, which appear to be growing as a general rule uglier and more offensive year by year; those from the ateliers of the æsthetic paper-stainers being even more conspicuous than those of the ordinary manufacturers for bad design and worse colouring.[1]

Relief in stencilling.

Æsthetic paper-stainers, etc.

[1] Look at the mock dadoes, now so much in request, with sham mouldings and panellings, to which the paper-stainers' art vainly attempts to give a semblance of relief. A panelled dado, with a bold, honest chair-rail, made of wood and stained and varnished, is what the other thing pretends to be, and is not only satisfactory to the eye but useful into the bargain. Look, again, at the hideous olive-green tints, dark leaves on a darker ground, or *vice versâ*, edged with broad lines of gold that

1410. Any required tint can be given to whitewash by the addition of a little colouring matter. Thus, for example, a beautiful *cream colour* may be produced by the admixture of yellow-ochre, or a good *pearl* or *blue-gray* tint may be obtained by the addition of a little lamp-black or ivory black. It must be remembered that the more the whitewash the more will be the colouring matter required, and the amateur must also recollect that the colour will look far darker when wet in the pail than when dry on the wall. To decide on the precise tint to be used, and to bring the wash exactly to the depth of colour required, whether light or dark, it will be necessary to put a little with a small brush over a piece of white paper and allow it to dry. When dry, the colour of the wash will be shown as it will dry on the wall. If too dark, a little whitewash must be added by degrees to bring down the original preparation until the desired tint is obtained; and if too light a little more colouring matter must be added, sparingly and by degrees, until a satisfactory result is produced.

How to make coloured washes.

How to decide on depth of tint.

1411. To return, however, to the means of obtaining washes of certain colours, a good *fawn colour* is made by adding four parts of umber, one part of Indian red, and one part of lamp-black to the whitewash. A *stone colour* is made by adding yellow-ochre with a very small quantity of blue-black, and the cream colour above mentioned may be deepened to *straw colour* or *buff* by using more yellow-ochre. *Warm tints* may be imparted to whitewash by adding a little blue-black, or indigo, or orange red, or Venetian red. Any shade of pink or salmon colour may be made by vermilion; cobalt will give a *blue* or *French gray* according to the quantity that is used, and *green* may be produced by mingling indigo and yellow-ochre, more of the former being used when a *blue green* or *dark green* is wanted, and more of the latter when lighter tints of green are desired. Sulphate of iron will also give a warm tint to whitewash. For interior walls the use of colour is desirable, but for the outside walls nothing more should be done than give the wash a warm tint by the admixture of some of the colouring substances mentioned

Coloured washes of various kinds.

Warm tints, etc.

Colour for external walls

are now considered by those who follow the fashion of the day—through want of knowing better, and through absence of any germs of good taste in themselves—satisfactory back-grounds for pictures and china; though the latter would look far better relieved by a backing of polished wood, and the former on tinted walls, with no caricatures of flowers, fruit, and foliage wandering over them, to distract the eye from all that should form the chief points of view. It is only possible to look forward and say, "*Meliora spero.*"

above. A *yellow* or *gray* wall for the exterior of a building is not nearly so pleasing to the eye as plain whitewash, or whitewash sufficiently tinted as to take off the extreme brilliancy that accompanies a pure white surface; nor does it afford so good a back-ground for trees, shrubs, creepers, and climbers.

Mixing and applying washes.

1412. Lastly, it is necessary to repeat that care is needful, not only in cleaning a wall or ceiling for the reception of colour, but in mixing the colouring matter itself and applying it. The whitewash itself should be carefully mixed, the preparation being carefully stirred together with a round smooth stick or a wooden spoon of large size, until the water and whiting are thoroughly incorporated ; and then the size should also have its share of stirring, and the colouring matter the same, so that no lumps may remain at the bottom of the vessel unmixed—an oversight which will tend to make the last part of the mixture somewhat darker in shade than that which was used from the same pail at first. It is necessary, too, to stir up the wash, whether white or coloured, every now and then while using it, as the heavier particles held in solution by the water have always a tendency to sink to the bottom and settle there.

Method to be observed.

1413. There is moreover a method to be observed even in the mode of applying the whitewash or colour wash. Not too much of the wash should be taken up at one time with the brush, as when the brush is overcharged splashing is the inevitable result. The strokes of the brush should all be backwards and forwards in one direction, as the lines traced by the hairs of which it is made will generally show in which direction the brush has been moved. Ceilings should be brushed the long way of the room, and walls straight up and down.

Materials, where procured.

1414. Lest there be any doubt as to where colouring matter for coloured washes may be obtained, it may be as well to say that it can be purchased in powder of any oil and colourman, ready for use. To prevent the presence of lumps, it is as well to pulverise every bit of the colouring matter to be used before adding it to the whitewash.

CHAPTER VIII.

SMITHS' WORK, INCLUDING FORGING, CASTING, FITTING, AND DRILLING.

Smiths' Work—What the Amateur may do—Forging : what it is—Common Fire enough for simple purposes—Forges necessary for most Work—Portable Forge and Bellows—The Fuel suitable for Forge—Tank close to Forge—Fletcher's Gas or Petroleum Forge—The Smith's Anvil—Its form and uses of its parts—The Tools required—The Smith's Tongs—The Smith's Hammers—The Smith's Chisel, and how to hold it—Forging more Difficult than it seems—Iron and Steel for Forging—Ordinary Operations in Forging—Drawing out—Welding—Stay for Wooden Uprights—Illustration of Process of Welding—Wrought-iron only can be Welded—Other Processes—Upsetting—Putting Collar on Iron Bar—Steel difficult to deal with—Manipulation of Steel—Tempering Steel—Tempering for Cutting Tools—Colour and Temperature—Temper may be Secured with precision—Case-hardening Iron—Putting Edge to Hatchet—How Case-hardening is effected—Brass and Copper may be Drawn out but not Welded—Patterns for small Castings—Melting the Metal for Mould—Wooden Moulds for small Leaden Castings—Method of making Wood Moulds—Moulds of Stone and Flanders Brick—Mould must be Warmed—Danger of Dipping Mould in Water—Sand Moulds for Castings—Varieties of Sand—Tools required by Amateur—Moulding Flasks—Trowel and Wire—Runner Sticks—Stamper—Making the Mould—The Process described—Mould for Article with Square Perforation—Appearance of Casting fresh from Mould—Skin or Scale of Iron Casting—Metals used for Casting—Gun Metal—Bronze—Brass—Crucibles—Crucible to be Annealed before it is Used—Intense Heat required in Melting Metal—How to Make the Fire—Pouring out Molten Metal—Conditions Necessary to Successful Castings—Finishing Processes—Turning—Fitting—Tools required in Fitting—The Vice: its Construction—Clamps of Lead or Tin—Different Kinds of Files—The Three-square File—Round Files—Half-round Files—The Fitter's Hammer—The Chipping Chisel, etc.—The Square, Callipers, and Straight-edge—Strike and Hack Saw—Surface Plate—How to Use the File—Chipping and Chiselling—Finishing with File—Application of Straight-edge—How to Work the File—Making Holes through Metal—To make Circular Holes—The Drill and Punch—Shape, etc., of Drills—How Rapid Rotary Motion is given to Them—Hand-brace for Large Holes—Archimedean Drill Stock—Countersinking Holes—Recessing Holes—Iron Hoops for Vessels—Putting Iron Hoop on Tub—Action of Hoop—Hoop Iron and Rivets—How to make Hoop—Inclination of Ends of Hoop—The Rivets and Riveting—Fixing Hoop in Place—Locks of Doors—Common Cupboard Lock—Its Parts and Construction—Locking and Unlocking—The Tumbler Lock: its Construction—Locks for Doors of Rooms—Rim Locks—Mortise Locks—Construction and Arrangement of Parts—Principle of Working—Lock out of Order—Causes Occasioning this—Damp Injurious to Locks—Knobs and Handles for Doors—New Kind of Door-handle—Keys of Mortise Locks, etc.—Picking a Lock—Replacing lost Key—Filing Nicks in Key—Cutting Blank Key.

1415. IN smiths' work, and indeed in all kinds of metal working, the amateur artisan will not do much, owing to the many difficulties that must be encountered and overcome, the cost of the apparatus required, and the time and practice required to make even an average workman at these difficult handicrafts. Indeed it may almost be said that whatever he does do in metal work will be chiefly in the way of repairs.

Smiths' work.

1416. But as many, however, may wish to know what are the chief things to be done in smiths' work, it is necessary to describe them briefly but clearly. It will be useful to every amateur to have the appliances and the knowledge requisite for doing such simple forging as is involved in heating and hammering out a piece of iron to any required form, and how to put a fresh prong to his garden fork if he has broken it. It is also desirable for him to know something about casting, fitting, and drilling; and the descriptions of these processes may be supplemented by instructions in the simpler ones of making iron hoops for casks or flower tubs, mending and cleaning locks and fitting keys to them.

What the amateur may do.

1417. Forging, then, must first claim our attention. This does not mean counterfeiting another man's signature, or illegally signing his name, but the less hazardous and more useful art of fashioning *wrought-iron* into such shapes as necessity or fancy renders desirable. The manner of handling the metal cannot well be described, but must be learned by observation and practice. A few instructions, however, may be given to the amateur which will render easy the acquirement of the practical knowledge, and these may be commenced with a few words about the fire, which is the first consideration.

Forging: what it is.

1418. A common kitchen fire, if clear and bright, will answer for some few simple purposes, but putting pieces of iron into a fire of this kind to make them red-hot, and then withdrawing them, if repeated several times, has the effect of spoiling the fire; and then, again, to successfully perform some of the principal operations requires a far higher degree of heat than can be got from a common fire. This heat is obtained by blowing air through the coals by means of fans or bellows. The former are used only for large work, and are driven by steam or other power; these, therefore, are of no use to the amateur, whose wants in this respect will be best supplied by a small forge of the hand-bellows class.

Common fire enough for simple purposes.

Forge necessary for most work.

1419. A portable forge is shown in fig. 664. This consists of an

iron table surrounded by a ledge on all sides, and supported on an iron stand. Below the table on which the fire is made are the bellows, worked by a rod attached at one end to the bottom of the bellows, and at the other to a handle by which it is alternately raised and depressed, thus opening and closing the bellows in turn, and causing a rush of air to the fire through the pipe A, whose orifice, through which the air is ejected, is shown in the ledge. Into this hole a short pipe or tuyere may be screwed, acting as the nozzle of an ordinary pair of bellows, and carrying the blast into the very centre of the fire.

Portable forge and bellows.

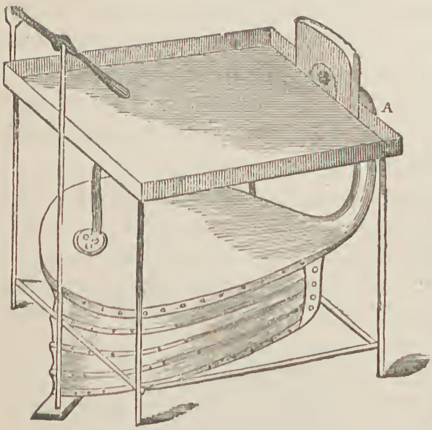


FIG. 664. PORTABLE FORGE.

1420. The fuel used is fine coal, generally called "smiths' coal" or "slack." A few ignited ashes being put on the table near the bellows' hole, some fuel previously damped put on this, and the bellows worked up and down, the fire will soon get very fierce. It can be moderated by merely stopping the supply of air, and it will remain alive for a great length of time after the blowing is stopped, a few strokes of the bellows soon bringing it up to a good heat again when it is required. The fire occupies but a small part of the iron table shown in the illustration. The ledge is useful for supporting the tongs and any tool that the amateur may be using when laid down for a moment, as well as for preventing any particle of red-hot fuel from falling on the ground below. It is often necessary in forging to plunge the heated iron into water as soon as it is withdrawn from the fire, and for this purpose some water should be at hand. A smith has a large tank close to the forge, but an iron pail filled with water will be sufficient for the amateur.

The fuel suitable for forge.

Tank close to forge.

1421. Amateurs who wish to have a small forge that has the merits of being perfectly clean, no nuisance either in lighting or use, and always ready for instant use, should provide themselves with the handy little gas or petroleum forge manufactured by MR. THOMAS FLETCHER,

4 *and* 6, *Museum Street, Warrington,* who will forward his list of specialities to any applicant. The entire apparatus is supplied complete, comprising blower, blow-pipe, hearth, tools, and india-rubber tubing for £3 6s. This price, however, does not include a hood, which, if required, can be made any shape desired for about 6s. extra. All small heating and brazing work can be done with this forge.

Gas or Petroleum forge.

1422. Next in importance to the forge is the anvil, on which the heated iron is beaten to the shape required. This should be close to the forge, so that the iron may be taken out of the fire and placed immediately on the anvil while it is still in a red-hot state, and in that condition in which it yields most easily to the blows of the smith's hammer.

The smith's anvil.

1423. The general shape of the anvil is shown in fig. 665. It is supported on a large block of wood in order to bring the upper surface within easy reach of a man when standing to his work. It has a flat surface or "table" at top slightly raised, and, in the better class of anvils, made of steel. At one end projects a cone or beak, rounded and tapering almost to a point, over which

Its form and uses of its parts.

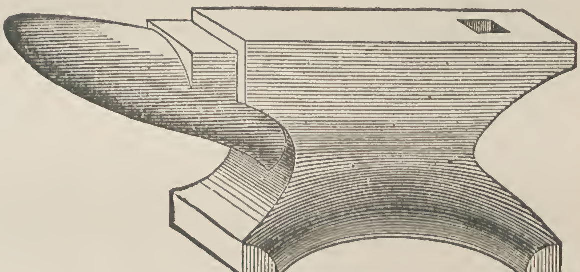


FIG. 665. SMITH'S ANVIL.

iron can be rounded. The use of the beak will be best seen when the reader considers the shape of a horseshoe, and how difficult it would be to bring it into this form without some appliance of the sort. In the table is a square hole, which serves as a socket, into which various tools may be fitted, one of the most common being a chisel on which a rod or bar may be placed and cut to any required length. Anvils may be had, varying in size and weight, from 28lbs. to 4 cwts. They are sold at prices varying from 5d. to 6½d. per pound, according to the make and finish of the anvil. The amateur, however, may pick up one well suited for his purpose at a marine-store dealer's for 2d. or 3d. per pound.

1424. The tools that are mostly required are a hammer, a chisel for

cutting iron, and tongs for handling red-hot iron, and for placing iron in the fire to be heated, and for withdrawing it from the fire when hot. To these may be added a few rasps, files, etc., whose use the amateur knows sufficiently well to render it unnecessary to say any more with reference to them than that they will often be found requisite in filing down any piece of work, or reducing the surface of a welded joint when it may be a little too thick. Of course a smith has an infinite variety of tools, but these will be all that an amateur will require in an ordinary way.

The tools required.

1425. The two sorts of tongs most commonly used by the smith in forging are shown in figs. 666, 667. They are made of iron, of any size to suit their work, and on the same principle as the carpenter's pincers, which they resemble to some extent. Their use is to hold a *short piece* of iron whilst forging it, to return it to, and to remove it from, the fire. When heating and beating out one end of a long bar of iron to any required shape, the other end may be held in the hand without the intervention of tongs.

The smith's tongs.

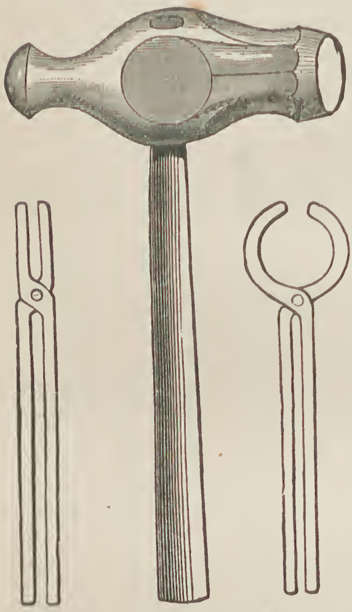


FIG. 665. TONGS. FIG. 668. HAMMER. FIG. 667. TONGS.
SMITH'S TOOLS.

1426. The hammer required for smiths' work or forging is generally double headed, and of the form shown in fig. 668. It weighs from three or four ounces to as many pounds, different weights and sizes being required for different kinds of work. The amateur will find that one weighing about one pound will be the most suitable for his purpose.

The smith's hammer.

1427. The smith's chisel is represented in fig. 669. It is not the chisel that is placed upright in the socket made for its reception in the anvil, but one which may be held with a handle in the same manner as the hammer. It will be noticed that a deep groove runs round one end of the chisel. A hazel rod is often bent round this groove,

The smith's chisel: and how to hold it.

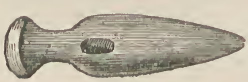


FIG. 669. SMITH'S CHISEL.

and the ends twisted together like the strands of a rope, thus preventing the jarring of the hand and arm, which is felt to a most unpleasant degree when the chisel is held by an iron handle, especially if the blows delivered on it are of necessity heavy. In cutting a thick bar of iron, one man generally holds the chisel while another strikes it with the hammer.

Forging more difficult than it seems.

1428. These tools, as it has been said, will be sufficient for all ordinary purposes, because forging is a branch of mechanical manipulation that cannot be gone into very fully by the amateur without skilled assistance; although to look at a smith at work, one would think that only strength is required. In reality, however, it requires a lifetime to become a proficient. The amateur, it must be repeated, should only attempt simple jobs; beyond effecting these, the chief use to him of a knowledge of forging will be to renovate and repair his steel tools, and for this purpose it will be extremely useful.

Iron and steel for forging.

1429. Both iron and steel for forging purposes can be purchased either in round, square, or rectangular bars, or in sheets. The price of iron is about 2d. per lb.; steel varies according to quality, from 3d. to 8d. per lb.

Ordinary operations in forging.

1430. Some general instructions may now be given with regard to ordinary operations in forging, one of the principal of which is "drawing out" iron, and another "welding;" processes which must now be described.

Drawing out.

1431. The iron must be made hot in the forge, and beaten or hammered out into the required shape upon the anvil. The proper heat for iron when it has to be *drawn out* (for example, beaten out into a point, narrowing gradually till the point is made), or made smaller, or worked into a different shape, is a bright red. For *welding*, that is, the uniting two pieces of wrought iron by laying the ends one upon another and hammering them, the heat should be what is called a "welding heat," that is, a white heat, so hot that if made hotter the iron would melt.

Welding.

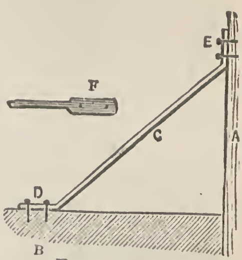


FIG. 670. STAY FOR WOODEN UPRIGHT.

1432. Let us take two very ordinary operations for illustrating these processes. There are two pieces of wood at right angles to each other, as A and B in fig. 670, and it is desired to give strength and support to the upright A by connecting it with the horizontal

piece B, by means of an iron stay. A piece of iron bar C having been procured, about $\frac{5}{16}$in. or $\frac{3}{8}$in. in diameter, the ends, D and E, are successively heated to red heat and bent to the required angle, and beaten out flat beyond the bend, as shown at F. Holes for the admission of screws are punched in the iron when it is red hot, or bored with a drill. If the amateur has a drill he had better use it, and afterwards deepen the holes on the outside with a counter sinker; if he has no drill, he can punch the holes, reduce the burr caused by punching with a flat file, and afterwards clear the holes thus made, or work them to the requisite size with a rat-tail file.

Stay for wooden upright.

1433. Again, to illustrate welding, let us suppose that the amateur has broken the centre line or prong of his garden fork; a piece of iron of the requisite width is obtained, and the fork at A, in fig 671, and the piece of iron to be added at B, are both heated to a white heat. The fork is then placed on the anvil, and the new piece is laid on the broken prong by aid of the tongs, and the two pieces are incorporated by a few sharp blows of the hammer. The iron must then be placed once more in the fire, brought to a white heat, and the process of beating repeated, to bring the two pieces of iron completely together. When this has been done, the end of the new piece can be heated and drawn out until similar in appearance to the other prongs. It must be noted that only *wrought iron* can be dealt with in this way; cast iron articles when once broken cannot be united or mended by the amateur, or by any one else for the matter of that, so as to be serviceable again. When a cast iron article is broken it is good for nothing else but to be melted down in the furnace again for recasting.

Illustration of process of welding.

FIG. 671.
NEW PRONG TO GARDEN FORK.

Wrought iron only can be welded.

1434. It may further be of advantage to the amateur to explain the process known as "upsetting," and also how to put a collar on a bar of iron.

Other processes.

1435. When a piece of iron or steel is wanted with an enlargement at one end, as in fig. 672, or even at both ends, or when a bulge or thickening is required in the middle, as in fig. 673, the place where it is wished to form the lump is made bright red, and the end of the iron is then

FIG. 672.
"UPSETTING" END OF IRON BAR.

brought down on the anvil with great force, the bar being occasionally hammered a little to keep it straight. Any operation of this kind is technically called "upsetting."

Upsetting.

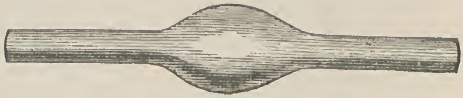


FIG. 673.
ENLARGEMENT IN MIDDLE OF IRON BAR.

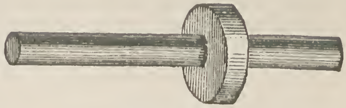


FIG. 674.
COLLAR ON IRON BAR.

1436. Should a collar be required on a bar of iron, as shown in fig. 674, it is thus made: the place where the collar is required is heated and slightly upset; another piece of iron rather larger than the collar is then bent and put on in its place. Both pieces are now raised to a white heat, and welded together by hammering. The illustrations in each case are somewhat exaggerated, but they will serve to show the amateur the nature of the operations and the method of performing them.

Putting collar on iron bar.

1437. Steel is far more difficult to deal with than iron. The amateur will not be able to weld steel, but it can be upset without difficulty. Great care must be taken never to heat steel more than cherry red; if raised to a white heat it is utterly spoiled for most purposes.

Steel difficult to deal with.

1438. Steel has the peculiarity of becoming very hard when raised to a red heat and suddenly cooled. It then becomes so very hard that no file or cutting tool will "touch" it, or make any impression upon it. After forging steel, if it has to be turned or filed, it should be annealed by making it red hot and allowing it to cool very gradually. For some purposes merely burying it in the ashes of the forge will suffice, but for others the steel must be buried in charcoal or sawdust, enclosed in an iron box, the whole raised to a red heat, and allowed to cool gradually without exposure to the air. It can at any time be hardened by raising it to a red heat, and suddenly quenching it in cold water or oil; the former is cheapest, but the latter is best; either, however, will do. Very small steel drills are hardened by heating them in the flame of a candle, and suddenly plunging them into the grease or tallow of which the candle is composed. Thin sheets of steel, if heated and plunged in water, are almost certain to warp or crack; they are therefore hardened by laying them, whilst red hot, between two cold pieces of iron.

Manipulation of steel.

1439. When steel is hardened in this manner it is much too hard to

be serviceable for most purposes, it must therefore be "tempered" or partially annealed. This is effected in a variety of ways. **Tempering steel.** Sometimes the steel is made so hot, that a piece of soft wood being rubbed against it, the particles of wood rubbed off will burn; it is then again quenched in water. Sometimes it is made so hot that a few drops of oil being put about it will catch in a flame; it is then immediately quenched.

1440. For cutting-tools, the best plan of tempering is to rub the already hardened steel in brick, or to grind it until bright, and then lay it upon a large piece of red-hot iron until it is of **Tempering for cutting-tools.** the desired temper. The temper is easily known by the colour, because after it has been in contact with the hot iron for a few minutes it will gradually become a light yellow or straw colour; and if the steel is a tool for cutting iron, it should now be quenched in water. If the steel be left on the iron, its tint will gradually get deeper until it is a purple colour, which is the colour for brass-turning tools; a little longer and it will become a light blue, which is the right temper for wood-turning tools. There is not the slightest difficulty in telling when steel is at the proper temperature, and if allowed to get too low in temper or too soft, it can be hardened afresh and again tempered.

1441. The following table shows the colour and temperature required in hardening and tempering various tools and **Colour and temperature.** metals:—

Tools, etc.	*Colour.*	*Heat. Fahr.*	*Tools, etc.*	*Colour.*	*Heat. Fahr.*
Lancets	Pale straw	430°	Swords and Watch-springs	Light purple	530°
Razors	Dark yellow ...	470°	Softer ditto	Dark purple	550°
Pen-knives	Dark straw ...	470°	Small fine Saws...	Dark blue ...	570°
Chisels and Shears ...	Clay yellow ...	490°	Large Saws	Blue	590°
Adzes and Plane-irons	Brown yellow ...	500°	Hand Saws...	Pale blue ...	610°
Table-knives	Very pale purple	520°	Very soft temper	Greenish blue	630°

1442. The temper required may thus be secured with the utmost precision, as the gradual change of colour in the metal shows most distinctly every degree of oxidation from one end of the **Temper may be secured with precision.** scale to the other. All that is necessary is to watch the changes of colour with the utmost attention, and when the right shade has been reached to remove the steel from the iron and plunge it into water.

1443. Iron in itself has not the property of becoming hardened in this manner. It may be heated to any extent and dipped in water or oil, and when taken out is very little harder than before; **Case-hardening iron.** but by using certain chemicals or compositions it may be hardened on the surface, or, as it is technically called, "case-hardened."

This is all that the smith does when he puts what he calls a steel edge to a hatchet, or a pick, or bar-iron, or any similar tool. He does not weld steel and iron together, but simply hardens the iron itself.

Putting edge to hatchet.

1444. The case-hardening of iron is effected by making the iron red hot and rolling it in powdered prussiate of potash. The iron is then returned to the fire until the potash melts or gets creamy; it must then be suddenly cooled by immersion in water. Another way of accomplishing the same object is to burn some scraps of leather or bones, then wrapping the iron to be hardened in this and raising the whole—for iron, charcoal, and all must be put into an iron box, the charcoal completely covering the iron, and plunged into the fire—to a bright red heat. The iron is then taken from the fire, removed from the box of animal charcoal and suddenly quenched in urine. This is a very offensive operation, but it is cheaper than the potash method previously described, and it has the great advantage of allowing a large number of articles to be hardened at the same time. In this method, should it be of importance that certain parts of the iron are hardened while others are left soft, those parts required to be soft must be wrapped round with stiff clay.

How case-hardening is effected.

1445. It is not possible to weld either brass or copper, but both admit of being drawn out under the hammer. To do so they are warmed and suddenly quenched. This has the power of softening them—just the contrary result to the effect of the same operation on steel—hammering rendering them soft and brittle.

Brass and copper may be drawn out but not welded.

1446. The method of making patterns for castings has been explained in another part of this work, and with the manufacture of the pattern the amateur is advised to be content, sending the pattern to the iron-founder or brass-founder to have the casting made. It may, however, happen that, through one circumstance or another, the amateur may require to make some small casting for himself, and in order to render him some assistance in doing this the *modus operandi* shall be briefly described. In doing this we must consider the mould and how to make it, the metal and how to melt it, and lastly the casting and how to finish it.

Patterns for small castings.

1447. We must consider that the pattern has already been made, and in this case the mould must be made of sand. In casting or founding, the metal, whether it be iron, brass, gun-metal, bronze, or lead, must be made quite fluid, after which the molten stuff must be poured into the cavity made to receive it.

Melting the metal for mould.

1448. Very small articles in lead are sometimes cast in wooden moulds, two pieces of hard wood being prepared, having one side of each perfectly true or flat, so that when brought together they will make a good joint. Half the shape of the article to be cast is then cut out from each piece, and, of course, when the two pieces of wood are put together, the two *halves* of the mould must correspond exactly, or come opposite each other so as to make one *whole*. A passage must be also cut for the entrance of the metal into the cavity within. When ready the two pieces are firmly clamped together, and the molten metal poured into the mould. The hot metal will, of course, burn the wood, and after two or three castings the mould will be spoiled.

Wooden moulds for small leaden castings.

Method of making wood moulds.

1449. Stone moulds are more durable. Of course stone is more troublesome to work than wood, but if a soft, sandy stone is selected, the amateur will not have much difficulty in making a tolerably intricate mould. Flanders brick will also answer well for the moulds of some castings. When a great number of small castings of the same size are wanted, iron is generally resorted to as the best substance for the moulds. It is very difficult to carve iron to shape, but when the mould is once made there is no limit to the castings that can be made in it.

Moulds of stone and Flanders brick.

1450. If the mould is large it must be warmed and held over the flame of a candle, or, what is better, the flame of resin dust wrapped in brown paper. This will cover the face of the mould with a thin coating of soot, the effect of which will be to prevent the liquid metal from adhering to the mould. A fresh covering of soot should be given to the mould after every six or eight castings have been made in it. A bullet-mould is a good example of an iron mould for small castings. When engaged in this kind of work some are apt to dip the mould in water to cool it quickly. This is exceedingly foolish, because, if a drop or two of water remains in the mould, the water will suddenly be converted into steam when the metal is poured in, and the lead forcibly expelled from the mould, perhaps flying into the face of the operator and severely burning him. The amateur should always carefully dry his mould, whether made of iron or any other material, before the metal is poured into it.

Mould must be warmed.

Danger of dipping mould into water.

1451. For general castings by far the best moulds are those made of sand, and called sand moulds. In order to make a sand mould, a pattern is made the size and shape of the desired casting. The ama-

teur has been told, as it has been said, how patterns are to be made. It is now merely necessary to explain how to make these moulds by the aid of a pattern already known to the amateur; the moulding materials and tools, however, first claim our attention.

Sand moulds for castings.

1452. The moulding material used is sand, of three sorts, namely, moulding sand, facing sand, and parting sand. Of these, moulding sand is a mixture of common sand and sufficient road scrapings, or other binding material, to enable it to hold together. Facing sand is ground or fine moulding sand; the parts of the mould which will come in contact with the metal are made of this. Parting sand is generally made of ground coke; this is dusted over the joints of the mould to *part* them, or prevent them from adhering to each other.

Varieties of sand.

1453. The tools required by the amateur are few and simple, and such as he may easily make himself. Moulding flasks, shown in figs. 674 and 675, are skeleton boxes, or boxes without top or bottom. They are generally made of iron, but wood will answer for a makeshift. They are in two parts, and are

Tools required by amateur.

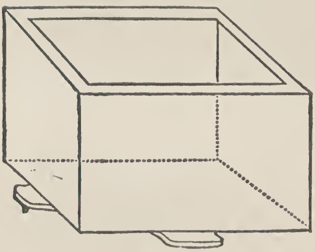


FIG. 674. MOULDING FLASK.

FIG. 676. MOULDING TROWEL (SIDE).

FIG. 677. MOULDING TROWEL (FRONT).

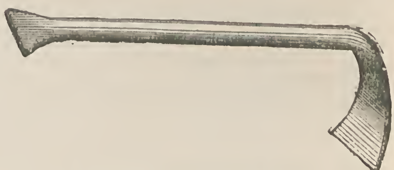


FIG. 678. MOULDING WIRE.

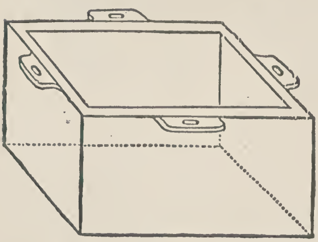


FIG. 675. MOULDING FLASK.

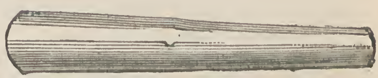


FIG. 679. RUNNER STICK.

furnished with ears or laps, the laps to the upper flask having pins projecting downwards, and the laps to the lower flask perforations corresponding to the pins to receive them.

Moulding flasks.

The trowel, two views of which are given in figs. 676 and 677, is a blade of thin steel set in a wooden handle. The wire, fig. 678, is simply a piece of iron wire or narrow iron plate, bent and fashioned as drawn. It is useful for smoothing corners, removing dirt from the mould, and so on. Runner sticks, one of which is shown in fig. 679, are pieces of round taper wood about 6in. long. They are used to make the holes necessary for running the metal into the moulds. The stamper, fig. 680, is a blunt-ended piece of iron or hard wood, very much like a pestle. It is used for stamping the sand into the shape of the pattern.

Trowel and wire.

Runner sticks.

Stamper.

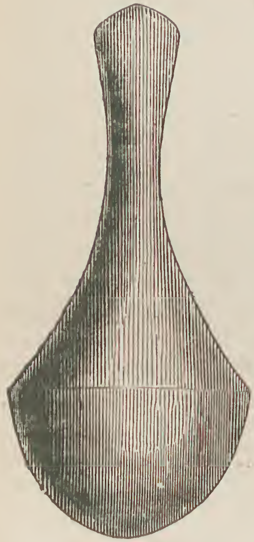


Fig. 680. Stamper.

1454. Having described the moulding tools employed, we can now all the better understand how the mould is to be made. The process to be adopted in this operation is as follows :—

Making the mould.

1455. Supposing that we want to cast anything in iron or other metal, we must take the pattern that has been previously prepared, and lay it flat upon a level board. The pattern must be buried in sand exactly to the extent of one half; the bottom part of the flask must now be put ears downwards over the pattern, and sufficient facing sand thrown into the flask to cover the pattern. On this place some moulding sand; press and stamp the sand well into the shape of the pattern; lay on some more sand and well ram it down, continuing the addition of sand and stamping until the flask is full. Then carefully reverse the flask and put the pattern upwards; with the trowel and wire trim off the sand, and press it well along the edges of the pattern. Exactly half should now be imbedded. Put on the top flask so that the pins go into the holes of the under one, dust over the sand with parting sand; bury the pattern in facing sand, put the small end of two running sticks through this sand, and let them touch the pattern and stand upright; throw in some moulding sand, and press, stamp, and ram in the same manner as before until the flask is full. Withdraw the runner sticks, carefully take off the top flask, remove the pattern very carefully—damping the sand imme-

The process described.

diately surrounding it will make this easier of accomplishment—repair any broken edge, clear the mould of all loose sand, and put both parts before the fire until quite dry. When the top flask is put on in place the mould is ready for the metal.

1456. If a mould is to be made for an article through which a square hole is required as the cylinder, the mode of making a pattern for which was described in Section 628, the operation that has just been described must be gone through *seriatim*, when the mould will present the form of a solid cylinder with a triangular groove in each half, together making up the square hole formed by the prints. Now take a piece of Flanders brick and rub it square, or file it square, the shape and size of the hole required, and lay that in the mould, each end fitting the square groove made by the print. This will be understood by looking at fig. 681, in which A is the bottom flask, B the sand, C the mould of the cylinder, and D the brick core laid in its place. Half the core fits into the under flask as shown in the figure, and when the top flask is put on the other half of the core fits it. When dry the moulds are ready to be used. Of course, when the metal is poured in it will fill all the mould except that part occupied by the core. This will not burn, and can easily be knocked out of the casting, in which there will then be a smooth square hole.

Mould for article with square perforation.

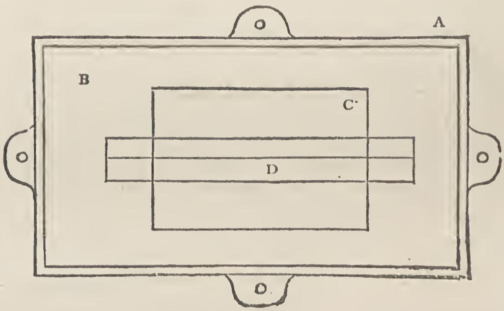


FIG. 681. CASTING WITH SQUARE HOLE IN IT.

1457. When castings come from the mould they look so rough that one unaccustomed to see them in that state would imagine them to be very badly made; but when the runners are knocked off and any little inequality removed, or what is technically called "cleared off," they look very different, and present a much more respectable appearance.

Appearance of casting fresh from mould.

1458. The skin or "scale" of an iron casting is, in consequence of the hot metal being chilled by contact with the mould, much harder than the inside. Sometimes it will be so hard as to spoil the files or other tools that are brought into action upon it. Should this at any time be the case, the scale should

Skin or scale of iron casting.

be ground off, and then very little difficulty will be experienced in working the casting into shape.

1459. Various metals are used in making castings, the most common being iron, gun-metal, and brass. With regard to the composition of metals the following proportions will be found useful for castings of gun-metal, bronze, and brass. **Metals used for castings.**

GUN-METAL.—Bristol brass, 12lbs.; Zinc, 1½lbs., and Block Tin, ¾lb.; or, Tin, 1¼lb.; Copper, 11lbs. **Gun-metal.**

BRONZE.—For bronze castings the following is a useful composition:—Copper, 14lbs.; Tin, 4lbs.; Zinc, 6lbs. **Bronze.**

BRASS.—For brass castings the following is the mixture:—Copper, 4lbs.; Tin, 1lb., and Zinc, ¾lb.; or, should the brass be required very hard, Copper, 6lbs.; Tin, 1lb. **Brass.**

1460. The metals composing the mixture must be melted in a crucible or melting pot; these are sometimes made of clay, but those made of pure black lead, called plumbago crucibles, are preferable. They can be had in all sizes, the price varying according to the size. The smallest size made holds but a few ounces and costs threepence, the next size sixpence, and so on to the largest size, which costs five pounds. **Crucibles.**

1461. When these leave the maker's hands they are unannealed, and rapidly absorb moisture from the atmosphere; if, therefore, the first time of using the heat is raised rapidly, they are certain to crack or "fly." This, however, can easily be prevented by annealing them before using them. This is done by putting them first into a common oven; when taken from the oven they should be put over a slow fire, and then on a fire where they can get thoroughly red-hot. They can now be used whilst hot, or allowed to cool for future use at any time when required. No further annealing or precaution is necessary, but they can be used until they are worn out. The shape of a plumbago melting pot is shown in fig. 682. Crucibles which do not burn away and which will stand all fluxes are supplied by Mr. Fletcher, of Warrington (see page 650), for 4d. each. **Crucible to be annealed before it is used.**

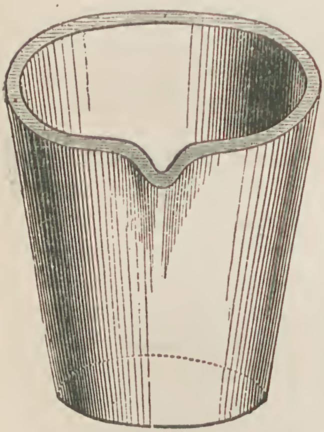


FIG. 682. PLUMBAGO MELTING POT.

1462. The heat required to melt the metals is very intense. A common fire is not sufficient, but the heat can be got in the fire made on the portable forges already mentioned.

Intense heat required in melting metal.

1463. The best way to make a fire for this purpose is to make a small fire first, level it, and put on the pot, then lay the coal all round it until level with the edge and in the shape of a pyramid. A strong blast should now be applied by means of the bellows until the pot is red-hot; throw in the metals and continue blowing until they are quite fluid. Then the pot should be taken from the fire by means of an iron hoop with one or two bars projecting from it, and the metal poured into the runner holes of the mould. A stick should be held to the lip of the pot, so as to keep back the metallic scum and prevent it from running into the mould.

How to make the fire.

Pouring out molten metal.

1464. If the mould has been well made and is nice and smooth, the metal well mixed and quite fluid, and the pouring skilfully and carefully conducted, a good casting will be the operator's reward. But although the casting may be smooth, free from blow-holes or not honeycombed, sharp and straight with regard to its edges, and, in short, *as a casting*, thoroughly well made, it is still much too rough and uneven to be used as the working part of any model, or as part of any machine or contrivance that is expected to work evenly and smoothly. All castings, indeed, must be rendered fit for service by fitting and turning in the lathe.

Conditions necessary to successful castings.

1465. It is the final fitting and turning, as well as all the preliminary work of making a casting, that renders this work more unsuitable for the amateur than other employments connected with the building trade. As far as turning goes, a stronger lathe is required than that which is used for turning articles in wood, and other materials softer than metal; but the processes employed and the tools and aids that are used are much the same, though adapted to suit the hardness of the material that has to be turned. Fitting consists in suiting the various component parts of a machine one to another. The fitter, in fact, in an engine factory is one of the most useful of mechanics; he fits together the various parts of machines, as it has been said, drills the holes that may be required, files and polishes those parts which are exposed to the view, or those which ought to be neat and smooth. He also files and brings to a true surface those parts sliding or work-

Finishing processes.

Turning.

Fitting.

ing in each other. He is only rivalled in importance by the turner in metals, who does all the circular work, large holes, etc.; but even this the fitter puts together.

Tools required in fitting.

1466. The principal tools required in fitting are a vice, files of different sorts, chisels for chipping, gouge chisels, straight-edge, scribe, bevel, hack-saw, scrapers, and surface plates. We will finish our necessarily brief account of so important a subject as casting and fitting by a description and illustrations of some of these tools.

The vice: its construction.

Clamps of lead or tin.

1467. The vice is indispensable; it is made of iron, with steel jaws notched on the inside. A representation of the vice attached to a suitable bench is shown in fig. 683. The article to be operated on is placed between the jaws, and the screw turned until the piece of metal is firmly fixed in the most convenient position. Should the article be polished, a pair of lead or tin clamps, as shown at fig. 684, must be placed between the jaws and the article, to prevent any damage to the latter from the notches of the vice. A small hand-vice to be held in the hand will also be found very useful for holding small articles.

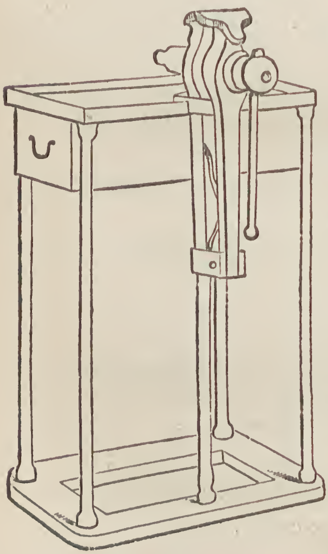


FIG. 683. VICE FOR FITTING.

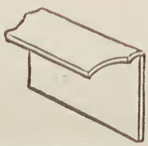


FIG. 684. CLAMP FOR JAWS OF VICE.

Different kinds of files.

1468. Files are of several sorts and shapes, and there are several different sizes of each sort and shape. The sizes are calculated in inches, according to the length. Those with the coarsest teeth are called "bastard-cut;" the next, the "second cut;" the next, the "smooth;" and the finest, the "dead-smooth." Of shapes there are the "three-square" or triangular; the "square;" the "round parallel," that is of the same diameter throughout; the "round taper" or rat-tailed; the "half-round;" the "flat hand;" the flat parallel;" the "fish-back;" with warding files for keys, saw files, and many others used for special work or trades.

1469. The three-square file is used for roughing down, or taking

the scale off a casting. Of this sort the amateur will want a 14in. **The three-square file.** bastard-cut and a 10in. second cut. Square files are used for filing out square or rectangular holes; of this kind of file a 6in. and 4in. will be found of great and frequent service. In **Round files.** addition to these, the amateur fitter should possess one 6in. round parallel file, and a 12in., 8in., 6in., and 4in. round taper file for filing out or enlarging holes, filing curved corners, **Half-round files.** and so forth. Several sizes of the half-round file of the finer cut should be purchased, as its peculiar formation renders it suitable for flat, curved, or angular work; and an 8in. smooth, and a 6in. and 4in. dead-smooth flat parallel file should be added to the stock, which should also include two 4in. fish-backed files, two or three thin warding files, and the same number of small triangular saw files.

1470. The fitter's hammer is of the form shown in fig. 685; it should weigh about 14 ounces, and the end of the handle should be furnished **The fitter's hammer.** with a sort of knob to prevent it from flying from the hand of any one that is using it. The chisels used by the fitter are very different to those used by the carpenter and joiner.

FIG. 685. FITTER'S HAMMER.

1471. The chipping chisel is shown in fig. 686, lengthwise at A, and in plan as the cutting end at B. In the same way the cross-cut

A B

FIG. 686. FITTER'S CHIPPING CHISEL.

A B

FIG. 687. FITTER'S CROSS-CUT CHISEL.

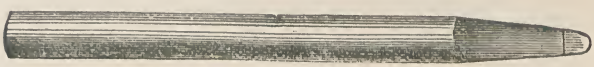


FIG. 688. FITTER'S GOUGE CHISEL, NO. 1.

FIG. 689. FITTER'S GOUGE CHISEL, NO. 2.

The chipping chisel, etc. chisel is shown in fig. 687, at A and B. Two varietise of the gouge chisel are shown in figs. 688 and 869. They are all made of steel, but, unlike those of wood, they have no wooden

handles. The cutting edges are ground off part from each side. They are tempered until the *edge* is a bright yellow. Should they happen to break, they can easily be drawn out at the forge, re-tempered, and ground.

1472. The square used in fitting is similar to that used in wood-working, but it is much smaller, and made wholly of steel. The amateur fitter will also require callipers—an instrument already described in Carpentry and Joinery—for gauging the width and size of a piece of metal which is required to be parallel. The straight-edge is made of steel, and is used to apply to a piece of metal to test its straightness and evenness of surface. The strike or scribe is a piece of steel looped at one end and pointed at the other, like an iron skewer. It is used for marking lines on metal. The bevel, shown in fig. 690, is something like a square, but the blade is movable so as to be set at any angle. It is kept from altering by tightening the screw; it is made of steel. The hack saw is represented in fig. 691. It is a thin blade of steel fixed in a frame for the convenience of working. Saws of this kind can be bought of different thicknesses. They are used to cut the nicks in the heads of screws or to cut metal. It is used dry. Of course it will often want sharpening; but the teeth must not be set in the same manner as those of saws for cutting wood are set, but must be left straight and of the shape shown at A. Scrapers of steel, of the shape shown in fig. 692, are very useful for making steam or air-tight faces or joints. The surface plate shown in fig. 693 is made of cast-iron. Its top is a *perfectly true* surface; its

The square, callipers, and straight-edge.

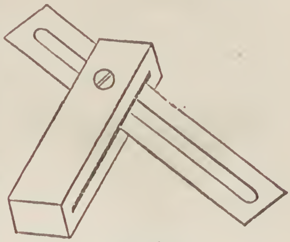


FIG. 690.
FITTER'S BEVEL.

Strike and hack saw.

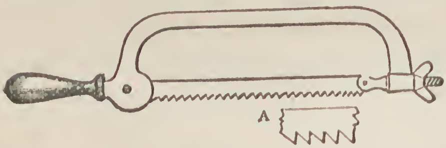


FIG. 691.
HACK SAW FOR METAL.

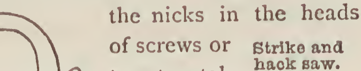


FIG. 692. STEEL SCRAPER.

Surface plate.

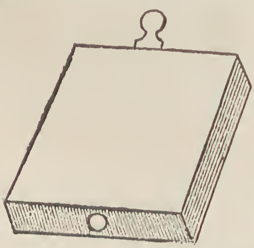


FIG. 693. SURFACE PLATE.

edges are square with the top and with each other. No one who wishes to make good work should be without one.

1473. The enumeration and description of the tools used by the fitter must yet be supplemented by a short account of the process of chipping and filing, and the way in which each may be best done. When we desire merely to make the surface of a piece of metal look smooth, the metal must be put between the jaws of the vice, and firmly held there by turning the screw and bringing the jaws tightly against the article between them. A rather rough file, furnished with a handle, must now be taken and passed evenly over the surface, the handle held in the right hand, the left pressed upon the point of the file. The best position for standing is with the left foot advanced. The file should be pushed forward slowly, slightly raised from the work, and brought back swiftly; for this reason, namely, that all the work is done by the forward stroke; therefore the time taken by the return stroke is lost.

How to use the file.

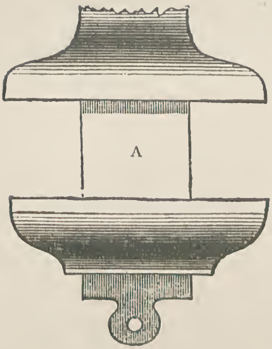


FIG. 694.
BLOCK OF METAL IN VICE.

1474. We will suppose, to illustrate the processes of chipping and filing, that a block of iron is required—that we have the casting, but that it is rather too large; also, that it is of importance that it should have flat sides, and every side exactly square with its neighbours—in short, a perfect cube. Fix it firmly in the vice as at A in fig. 694; take the hammer in the right hand and the chisel in the left. Place the cutting edge of the chisel against the edge of the block, as shown in fig. 695, and strike some tolerably heavy blows upon the top of the chisel in rapid succession, until the whole of the scale on one side of the casting is chipped off. When this has been done, let the amateur fitter take the largest file he has and shoot it across the surface of the

Chipping and chiselling.

Finishing with file.

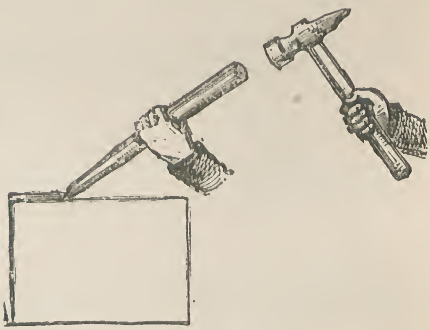


FIG. 695.
CHISELLING SURFACE OF BLOCK.

iron, filing away until the chisel marks are removed. Then apply the

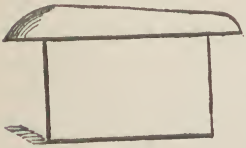


Fig. 696.
STRAIGHT-EDGE.

Application of straight-edge.

straight-edge to the surface in manner shown in fig. 696. If not straight, but in the form of a slight curve, higher in the middle than at the edges, try again, keeping the right elbow down and pushing the file forward in a straight line, instead of allowing it to move up and down as most beginners will.

How to work the file.

1475. The great secret of success in this, as in most other things, is to think of the work in hand and how best to do it. The file should be worked thus: when the point of the file is put to the work, press heavily with the left hand and lightly with the right. As the file is pushed forward, gradually relieve the pressure from the point of the file and press more upon the handle. When the file is at half-stroke the pressure upon both extremities should be equal, and at the termination of the stroke the pressure should be just the reverse of what it was at the commencement; or, in other words, the great pressure that was put upon the point should be transferred to the handle, and the light pressure upon the handle laid upon the point. When this side is filed straight, chip and file the remaining sides, frequently applying the square and straight-edge to the work in order to see where the metal should be removed for it to become the desired shape.

Making holes through metal.

1476. Another branch of the fitter's work consists in making holes through metal. To drill a hole through a thin piece of metal is very easy, and can be done with little labour, no skill, and very simple apparatus. Small holes through long lengths require great patience and skill, and special machinery. The amateur will mostly require to drill holes in thin metal, so it will be sufficient for all general purposes to describe the tools that are absolutely necessary for making these.

To make circular holes.

1477. To make a circular hole circular motion is necessary. This motion can be given either to the tool or to the material through which the hole is required; for general work the tool is usually put in motion whilst the article is stationary. All holes, whether small or large, should have their position marked out, and an indent or centre mark made exactly in the centre of the place where the hole is required. This centre mark, which serves as a commencement for the hole and a guide for the drill, is made with a centre punch, shown in fig. 697. In using this tool the

point must be placed on the spot requiring the work, and a smart blow with the hammer given upon the head. This will cause the point of the punch to sink into the metal, and when it is withdrawn a circular indent will be seen of a depth corresponding to the nature of the material and the weight of the blow.

The drill and punch.

1478. The drills, or cutting instruments, one of which is shown in fig. 698, are of the best steel, square and taper at one end, and flat and thin at the other. The thin end is the cutting part; it is ground to a point at about the same angle as the centre punch, and also a little is ground off each side of both the edges of the angle. Of the multiplicity of contrivances for giving a rotary motion to the drill, one of the most common is shown in fig. 699. It is constructed wholly of iron. The tail A is fastened between the jaws of the vice, a drill C of the size required being fixed in the square hole at the end of the spindle B. A bow of elastic wood, with a slack string or gut fastened to its extremities, is used for putting the drill in motion, the string of the bow being wrapped once or twice round the pulley D, so that the bow is strained tolerably tight. The article to be pierced is held in the left hand and pressed against the point of the drill. One end of the bow is grasped in the right hand and moved backwards and forwards, thus producing an alternate backward and forward circular motion of the drill; in a few minutes the drill will cut a circular hole through the metal held in the hand.

Shape, etc., of drills.

How rapid rotary motion is given to them.

FIG. 697. CENTRE PUNCH.

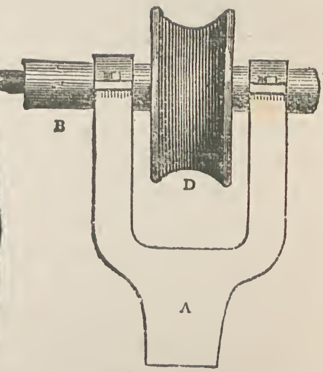


FIG. 699. INSTRUMENT FOR IMPARTING ROTARY MOTION TO DRILL.

FIG. 698. DRILL FOR METAL WORK.

1479. Holes up to $\frac{3}{16}$in. in diameter may be drilled with an apparatus of this description, but those from $\frac{3}{16}$in. to $\frac{5}{8}$in. in diameter must be bored by aid of the hand-brace, shown in fig. 700; and to be of service the hand-brace must be set in a drill frame as shown in the same figure. In this, A is the table on which the article to be drilled is placed. This table has a rib running along the bottom, which is gripped tight between the

Hand-brace for large holes.

jaws of the vice when the apparatus is in use. From the table and at right angles to it rises an upright B, on which a socket arm C slides up and down, having a set screw G at one end to fasten it in the desired position against B, and at the other a circular plate pierced to receive the screw D, one end of which has a round head with two holes through it, and the other end a centre mark or indent to suit the centre point of the hand-brace. To use this drilling frame, the drill E is inserted into the hole of the hand-brace F, the point being brought firmly against the article on the table, the arm C being adjusted according to the length of drill and the thickness of the article, and kept where set by tightening the set screw G. Another kind of brace, called the ratchet-brace, is sometimes used instead of the hand-brace.

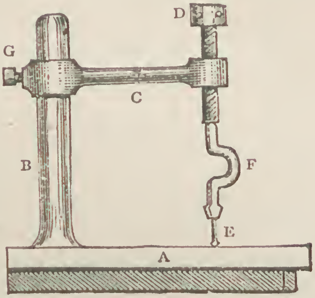


FIG. 700.
HAND-BRACE FOR METAL WORK.

1480. One of the neatest contrivances for drilling a small hole is that called the Archimedean drill-stock, illustrated in fig. 701. It consists essentially of a screw A A, with a socket at the lower end for carrying the drill and a nut B. The screw is of a very long pitch, and has several threads. The drill is placed in its position, and the butt D held against the operator's stomach. By taking hold of the handles C, C, fastened to the nut B, and drawing it quickly up and down, the screw will revolve and carry the drill with it. This kind of drill, like the vice drill, is only serviceable for drilling holes up to $\frac{3}{16}$in. in diameter.

Archimedean drill-stock.

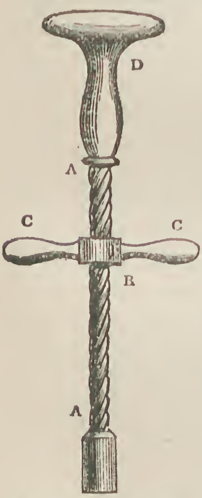


FIG. 701. ARCHIMEDEAN DRILL-STOCK.

1481. Holes can be drilled through brass, gun-metal, cast iron, etc., without the use of any lubricating material, but wrought iron and steel must be kept well moistened with oil if a small one, and soda water and oil if a large one.

1482. It is frequently necessary to counter-sink a hole, that is, to enlarge its orifice in the shape of a V. This is done by aid of the counter-sinker, shown in fig. 702, which is worked in the hand-brace. Sometimes it is desirable to recess a hole,

Counter-sinking holes.

and make it larger with a flat bottom. This is done with the pin drill, or scoop, shown in fig. 703. The pin A, being the size of a small hole, keeps the scoop central. This description of drill may be used in either the hand or the ratchet brace, according to size, the ratchet-brace, owing to the peculiarity of its construction, permitting a much greater power to be applied to the drill than can possibly be given to it in the hand-brace.

Recessing holes.

FIG. 702. COUNTER-SINKER.

FIG. 703. PIN DRILL.

1483. It is useful for the amateur to know how to make an iron hoop, and how to put it on the article for which it is intended. A cooper will charge at least 6d. for putting on a hoop, and as three or four new hoops will often be required for a small tub, the cost will be 1s. 6d. or 2s. The amateur, however, may with very little trouble put on his own hoops for about from one-fourth to one-third the amount named. An iron hoop may often be wanted for a water cask, or a wooden tub which is intended to hold an orange tree, myrtle, oleander, or any other large shrub which requires shelter within doors in the winter.

Iron hoops for vessels.

1484. Let fig. 704 represent a wooden tub in elevation. It will be seen that it is wider at the top than at the bottom, and that it is in the form of a cone turned upside down with the top cut off. A cask resembles in general form two of these *frusta* of cones connected at their bases, the widest part being in the middle where the cask swells or bulges out, and the narrowest part at the two ends, or top and bottom. From this it is apparent that the further a hoop is driven on, the tighter the staves of the tub or cask are brought together. Suppose that it is necessary to put a new hoop on the tub shown in fig. 704, at A. The materials required are some hoop-iron of an inch in width and some iron rivets. Hoop-iron of 1in. in width and upwards costs from 12s. to 15s. per hundredweight, and when less than 1in. in width about 17s. per hundredweight; but it may be bought from the ironmonger in small quantities at 2d. per lb., and the rivets from 8d. per lb. for the smallest to 3d. per lb. for the largest. Old hoops, which will do as well, or nearly so, as new ones,

Putting iron hoop on tub.

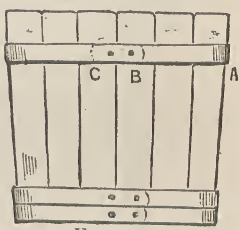


FIG. 704. HOOPS ON WOODEN TUB.

Action of hoop.

Hoop-iron and rivets.

may often be bought of the marine-store dealer for a few pence, and if too large they can be cut and made up again to the size required.

1485. Having the hoop-iron ready, measure the girth of the tub *a little below* the place where the hoop is to be fixed, so that the hoop may be sure to fit tightly, allowing from 2in. to 2½in. at each end, as from B to C, for the overlapping of the iron through which the rivets are to be thrust. Bring the ends together, somewhat in the manner shown in fig. 705, though this is exaggerated in order to show better what is meant; and then with a piece of chalk mark on each end the places through which the rivets are to be driven. This inclination of the ends of the hoop is made in order to make the circumference of one edge of the hoop a trifle less than the circumference of the other edge; and it must be remembered that it is the larger circumference which must be passed first over the bottom of the tub. The holes for the rivets must then be punched with a steel punch. The rivets, which are short pieces of soft iron with a projecting edge or shoulder on one side, are then put through the holes, the shoulder end being inwards and laid on an anvil, the riveting being completed by hammering the uppermost end of the rivet until the face is beaten out beyond the circumference of the hole made by the punch, thus bringing the ends of the hoop closely and tightly together. To take a hoop to pieces without injuring it, one side of the rivet must be filed off, and the rivet itself then punched out. To fix a hoop in its place, slip it over the bottom of the tub, having first turned the tub upside down, and then beat the hoop on as far as it will go by holding a flat piece of iron against the edge and striking the iron with a hammer. Care should be taken that the hoop be equidistant in all parts from the edge of the tub.

How to make hoop.

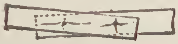


FIG. 705. OVERLAPPING OF ENDS OF IRON HOOP.

Inclination of ends of hoop.

The rivets and riveting.

Fixing hoop in place.

1486. Nothing gets out of order quicker about a house than the locks of the doors, especially if cheap locks have been used. They are always in use, doors being open and shut dozens of times in the course of a day, and it is a matter of wonder that they last as long as they do with all the undue pressure that is put on the spill that connects the handles and keys with the lever that acts on the catch. The simple latch fastening used for garden doors and doors of out-buildings generally—which consists of a bar secured to the door by a pin thrust through one end, the other being lifted by a short lever or by a knob attached to the bar—is so simple in its construction that it needs no detailed description. It will be necessary,

Locks of doors.

however, to describe and illustrate the principles on which locks are made, and to explain the chief causes by which they get out of order.

Common cupboard lock.

1487. In fig. 706 a representation is given of a common cupboard lock, the simplest kind of lock that can be made. In this and in all other locks used for doors the interior is concealed from view by a plate which fastens on to two more projections from the thin strip of metal which forms, as it were, the side of the box in which the key works, and through openings in opposite sides of which the bolt is moved backwards and forwards.

Its parts and construction.

In this lock A is the bolt or bar. This bar is cut deeply lengthwise at the upper part of one end, as shown at B, so that the part partly separated from the bolt may form a rough kind of spring which presses upwards against the frame of the lock. At the lower part of the same end two notches are cut, as shown at C, which work on the frame-work, each notch fitting or slipping on to it alternately as the bolt is moved backwards or forwards by the key. Midway in the lower part of the bolt is a semicircular notch in which the key acts to shoot the bolt backwards and forwards. This notch is shown at K. The key, which is tubular in form, fits on to a wire projecting from the lock-plate, and the slits or nicks in the projecting part of the key fit over iron or brass rings called *wards*, which are fixed to the lock-plate in the form of circles or parts of circles round the wire on which the barrel of the key fits as a centre.

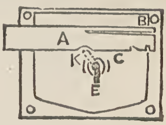


FIG. 706. COMMON CUPBOARD LOCK.

Locking and unlocking.

To lock the door the key is turned to the left hand, and the projecting part strikes against the left-hand side of the notch K, pressing the bolt forward, and compressing the spring B to an extent sufficient to allow the first notch at the lower part of the bar to the right hand to be raised off the frame of the lock, on to which the second notch slips as soon as the bolt is shot forward far enough to release the key. In unlocking the door the key is turned to the right hand, and the process that has just been described is reversed.

The tumbler lock: its construction.

1488. In fig. 707 a lock of better and more complicated construction is represented, called a *tumbler lock*. In this lock the bolt A is hollow between A and C on the side hidden from the eye of the observer, so as to allow the tumbler B to be placed behind it. The shape of that part of the tumbler which is hidden from sight is shown by the dotted line. It is fixed to the lock-plate by a pin E, and is pressed downwards by the action of the spring shown at F. On the end of the tumbler to the left is a projection

G, which fits into one or other of the notches C, D in the bolt A, according to the position of the bolt. There is a semicircular notch K in the lower part of the bolt A, about the middle, in which the key works. When the door is to be locked the key is turned to the left. The projection G is now resting in the notch D, and the first thing that is done by the key is to raise the tumbler B. The effect of this is to raise the projection G out of the notch D. The key then presses against the left-hand side of the notch K and shoots the bolt forward, when the tumbler B, relieved from the upward pressure of the key, is pressed down again by the spring F, the projection G falling into the notch C. In unlocking the door the process is reversed.

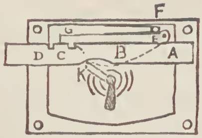


FIG. 707. CUPBOARD LOCK.

1489. The locks used for the doors of rooms are mortise locks and rim locks, a larger stock lock, or lock in the form of a box similar to a rim lock but larger, being used for a front door. Rim locks are used mostly for bedroom doors, which, for the most part, are not thick enough to take a mortise lock; they are simply attached to the door on the inside by long screws, the catch and lock entering an iron box with a brass projecting edge, screwed on to the door jamb. Mortise locks are used for the thicker doors of sitting-rooms, a cavity being formed for their reception in the style and broad centre rail by means of the mortise chisel: the bolt and catch works through a brass plate screwed to the edge of the door and into cavities cut in the opposite jamb, and faced with a brass plate. Rim locks are to a certain extent a disfigurement to a door, but mortise locks are not so, as the lock is concealed within the rail and style of the door, the knobs on either side, and the accompanying furniture being the only indications of its presence.

Locks for doors of rooms.

Rim locks.

Mortise locks.

1490. In fig. 708 the general form of the arrangement of the interior of the rim lock and mortise lock is shown. The construction and working of the lock is similar to that of the tumbler lock already described. The key E works against the tumbler B and in the notch K, the tumbler being fixed to the lock-plate at E, and having at the other end a projection fitting into the notches C, D, according to the position of the bolt, and pressed down by the action of the little spring X above it. It is with the catch rather than with the lock that we are here concerned. This catch or latch is a long bar F, sliding easily backwards and forwards to the extent of about ⅝in. or a little less, solid at the end where it projects from the

Construction and arrangement of parts.

door, that is to say at G, and bevelled at this end so as to slide easily over the bevelled brass rim of the box that holds it when the door is shut; at the opposite end is a bar H, at right angles to the bar F, generally called the tail of the latch. Behind H is a spring I, attached

Principle of working.

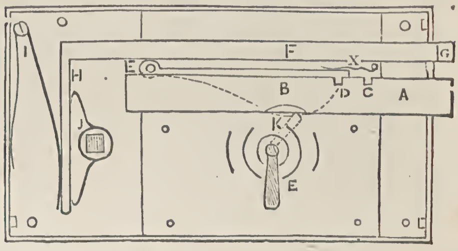


FIG. 708. INTERIOR OF RIM LOCK.

to the door-plate by means of a screw, pressing outward against the arm H, and thereby keeping the latch F out to its fullest extent, which is its normal position except when the door is being opened or shut. On the other side of H is a lever J, generally made of brass, the circular part of which projects through round holes in the plates of the lock in front and behind. In this circular part is a square hole through which passes the iron spindle, at each end of which is a door knob, fastened to the spindle by a small screw which goes through a hole in the collar of the knob, and enters a depression in the spindle, thereby rendering it impossible to pull off the handle as long as the screw remains in its place. When the handle of the door is turned to the left the upper part of the lever J is pressed against the arm H, which in its turn presses against the spring I, forcing it back. By this movement the end of the latch G is withdrawn from the box that holds it, and the door is free to open. As soon as the handle is released, whether the door be open or closed, the latch F is again restored to its original position by the outward pressure of the spring I.

1491. It is not often that the lock itself gets out of order, and when this is the case it is generally owing to the breakage or some injury done to the small spring X, which must be replaced with another purchased from the ironmonger. Occasionally some foreign substance may get between the wards over which the key works, or the wards themselves may have suffered displacement, in which case they must be restored to their original position. With regard to the latch, there are three causes which will throw it out of order. The first of these is the fracture or weakening by long use of the spring I, which can always be replaced by another which may be bought at the ironmonger's. Secondly, the lever J may be slightly displaced by undue upward or downward pressure on the spindle that goes through it, and

Lock out of order.

Causes occasioning this.

when displaced the softer brass will be gradually cut away by the harder iron within which it works, and after a while a new lever will be required. When this is the case a quantity of particles of brass that have been gradually worn away will be found within the framework of the lock. Lastly, the tail H may be broken away from the bar F, in which case it will be necessary to braze the pieces together again.

1492. Locks are liable, on account of the dampness of the air at certain times and the entrance of particles of dust, etc., to get rusty and dirty inside, and it is desirable that the amateur should at times take his locks to pieces and give them a good cleaning and oiling with olive oil, which will make them work smoothly and pleasantly. Of the various patent arrangements for the knobs and spindle we have said nothing, as space forbids a lengthened description. One of the best of these appears to be the Patent Keyed Door Furniture manufactured by MESSRS. WILLIAM TONKS AND SON, *Birmingham*, who have many specialities in the form of patent sash-cords, picture-lines, and other articles, which will prove extremely useful to the amateur. A catalogue and price list will be forwarded by Messrs. Tonks and Son to any address on application.

Damp injurious to locks.

Knobs and handles for doors.

1493. The worst of the old-fashioned spindle and knobs at either end, attached by means of a small screw that enters a semi-spherical depression in the spindle, is that the screw becomes loosened by constant use, and ultimately drops out, when the handle, of course, comes away from the spindle. This, however, is entirely obviated in the new kind of door-handle, or "furniture," as it is technically called, to which allusion has just been made, by the peculiarity of its construction. The edges of the spindle are notched, forming a screw-thread, up or down which the knob may be screwed. When the handle has been screwed up the spindle to a sufficient extent, a dovetailed key is fitted into an opening made for it in the base of the knob. The knob is thereby firmly attached to the spindle, and cannot be moved from its position, or in any way detached from the spindle, until the key is removed.

New kind of door-handle.

1494. The keys of mortise locks and rim locks are solid throughout, except the slits that pass over the wards; while those of box locks, drawer locks, cupboard locks, etc., are tubular, so as to fit over the wire that projects from the lock-plate. The solid barrelled keys of mortise and rim locks work in sockets formed for their reception in the plates of the lock. When a key is

Keys of mortise locks, etc.

lost, and the door happens to be locked, a smith will *pick* it, as it is technically called, with a piece of bent wire that passes over the wards.

Picking a lock.

1495. To supply the place of the lost key another may frequently be got from the ironmonger or marine-store dealer, who generally has a large bunch of old keys by him. If a key will not exactly fit, a little filing of the nicks with a thin flat file called a "warding file" may have the desired effect. The form of a key is shown in fig. 709. The nicks A and B fit over wards projecting at right angles from the lock-plate, the horizontal nicks at the top of each, *if there be any occasion for them at all*, passing over narrow flanges at the top of each ward. The nick C passes over a flange attached to the interior of a ward, *within* which the end of the key works, barely touching it if it touches it at all. The nicks shown horizontally must be cut with very narrow warding files. Blank keys without any nicks whatever can be purchased at the ironmonger's, which the amateur, with patience, can file and nick so as to suit and fit the lock. The outer plate of the lock should be removed so as to expose the wards and show where the nicks are to be cut, without resorting to the burglar's expedient of ascertaining the position of the wards by inserting a piece of wax into the keyhole, or a key-shaped tin plate coated on one side with a mixture of wax and yellow soap to take the impression of the wards, and serve as a guide for the making of a false key.

Replacing lost key.

Filing nicks in key.

Cutting blank key.

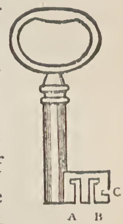


FIG. 709. KEY.

CHAPTER IX.

SOLDERING AND BRAZING—ZINC-WORKING, AND WORKING IN SHEET METAL — PLUMBING — GAS-FITTING — BELL-HANGING AND WIRE-WORKING.

Knowledge necessary for Zinc-working, etc.—Uniting Pieces of Metal—Soldering —Brazing—Soldering: for what useful—Composition of Solders—Tools and general Process—Cleaning the Surface of the Pieces of Metal—Tinning the Surfaces—Applying the Solder—Killing the Muriatic Acid — Soldering Iron or Copper Bit—Handy Apparatus for Amateur—To prevent Action of Solder at any particular Part—Soldering very thin Sheets of Metal—Process to be followed in Brazing—Penetration of Iron by Brass—Brazing small Articles—Working in Zinc—Sizes and Prices of Zinc Sheets—Joining Pieces of Zinc and Lead—The Roll Joint—Zinc need not be Painted—Zinc should be Underlaid with Roofing Felt—Flashings in Zinc-work—Gutters and Pipes in Zinc—How to make Zinc Piping—Attachment of Pipe to Wall—How to make Zinc Gutters—Tray of Zinc for Lining Box—How to make the Tray—General Principles of working in Sheet Metal—No special directions requisite—Corrugated Iron and Zinc Sheets—Putting up the Sheets—Prices, etc., of Corrugated Zinc and Iron—Illustration of Advantage of knowing how to Braze, etc.—Lamp for Bottom Heat—Contrivance for application of Bottom Heat—Plumbing and Gas-fitting—Joint in Plumbing: how to make it—Connecting Sockets for Pipes of Iron—Application of White Lead to Joint—Lead and Composite Pipes for Gas—How to Join them—Fitting to Taps, etc.—Lead, etc., must be Dry when Joint is made—Lining of Tea Chests good Solder for Tin—Plumbers' and Glaziers' Solders—Soldering without Heat—Useful Recipe for doing this—Brazing Iron, etc., without Heat—Recipe for the Process—Mending, etc., that may be done by Amateur—Tools, etc., required—Description of Process—Scraping Metal and Applying Acid—Putting Piece over Hole—Running in Solder—Bell-hanging and Wire-working—Tools required in Bell-hanging—Long Gimlets—Tubing in Walls for reception of Wires—Cost of Tools and Appliances—Bell-hanging expensive Work—Cost of Bell, etc., complete—Cost of Various Appliances—Cranks, and Direction of Wires—Illustration of Process—Bell Pull or Handle—Tubing and Wire: Change of Direction of Wire—Crank and Tension of Wire—Bell, and Mode of Hanging it—How the Bell is Sounded—Bell and Wires out of Order: how indicated—Knowledge of Wire-working desirable for Amateur—What can be done in Wire-work—Sizes and Prices of Wire—Gauges of Wires—Galvanised Fencing Wire—How to put up Wire Fencing—Straining Posts and Struts—Straining and Tightening Wires —How to Fasten Wire Loop—Intermediate Posts—Wire for Horticultural Purposes—Its various Uses and Application—Galvanised Netting: Widths and Prices —Straining Wire along Walls—Necessary Appliances—Articles made in Wire —Garden Sieve: how to make it—Circular Pea Trellis—Wire Trellis for Greenhouse, etc.—Hanging-baskets—Wire-work not Galvanised should be Painted—Good Paint for Wire-work—Black Varnish for Wire.

1496. For zinc-working, plumbing, gas-fitting, and all kinds of work in sheet metal, a knowledge of the processes termed soldering and brazing is absolutely necessary, and it is with a description of these processes that it will be needful to commence this chapter. By soldering and brazing the edges of pieces of sheet metal are joined together, and although it is better for the amateur for safety's sake to have all zinc working that he may require in the way of covering roofs, making zinc pipes, lining wooden cisterns, and similar operations done by the professional zinc-worker, and that he should call in the plumber and gas-fitter to rectify any leakage in lead pipes or gas-fittings, it is as well that he know how to make a joint in metal, whether sheet or pipe, and possess the few appliances necessary for doing so. If a man can do no more with regard to work of this kind than repair tin pots, kettles, etc., it will be of advantage to him, for the itinerant tinman seldom does his work effectually, and seems never to be at hand when his services are most required.

Knowledge necessary for zinc-working, etc.

1497. First, then, with regard to soldering and brazing. To explain these terms, in the first place, both of these may be described as methods of uniting pieces of either the same or different kinds of metal with a strong and, if necessary, water-tight joint.

Uniting pieces of metal.

1498. To effect this by the first-named operation, namely *soldering*, a compound metal called solder is used. This composition is only melted, the metals to be united not requiring to be heated purposely, but coming into contact with the melted solder they naturally get slightly warm.

Soldering.

1499. In the operation of *brazing* the metals to be joined must be raised to the melting point of the brazing composition, which is soft brass. Although this makes the strongest joint, the necessity for exposing the articles to such a great heat renders this operation inapplicable to many purposes.

Brazing.

1500. Soldering is very useful for joining copper and copper, copper and brass, copper and iron, brass and brass, brass and iron, tin and tin, and tin and any other metal. If the joint has to stand a rather high degree of heat—such, for instance, as the seams of a small copper steam boiler—a *hard* solder must be used. By hard solder is meant one that only fuses at a high temperature; a *soft* solder, on the contrary, fuses at a low degree of heat.

Soldering: for what useful.

Composition of solders.

1501. The following are the compositions of some of the most useful of solders and alloys, with the degree of heat required to melt each :

Tin.	*Lead.*	*Bismuth.*	*Mercury.*	*Melts at*
1 part	25 parts	...	...	558° Fahr.
2 „	1 „	...	...	340° „
2 „	2 „	1 part	...	292° „
5 „	3 „	3 „	...	202° „
5 „	3 „	3 „	3 parts	122° „

1502. We must now see with what tools and appliances soldering is effected, and the way in which this operation is performed. First, the surfaces to be united must be thoroughly cleaned and brightened—without this the metal will not adhere. The soldering iron must be warmed sufficiently to melt the solder; it must not be made red-hot, because the solder will not "hold to it."

Tools and general process.

Cleaning the surface of the pieces of metal.

1503. Whilst the iron is warming, *tin* the surfaces by brushing them over with muriatic acid, dipping them into melted solder, and quickly rubbing off the adherent metal. This, if done well, will leave a thin coat of solder. When it cannot be done thus, the surfaces must be tinned by means of the soldering iron. In this case they must be coated or washed with the acid as before, but the solder must be melted on the places required with the hot iron.

Tinning the surfaces.

1504. When tinned, the surfaces should be brought close together, a little acid rubbed along the joints, and the iron dipped in the acid and put against some solder, so that the melted solder will stick to the iron. The iron must now be applied to the joints, and drawn slowly along in such a manner that the metal between the joints is melted, and the joints filled up. A little practice will soon make the amateur tolerably skilful in doing this. The muriatic acid, or spirit of salt, as it is sometimes called, must be *killed*, or rendered neutral, before it is used, and this is done by putting one or two small pieces of zinc into it and allowing it to expend all its energy on this. Killed acid is much more effective than the raw or pure acid. Sometimes resin is used instead of the acid; but the neutralised acid is preferable, because it does not leave the work in such a mess as resin.

Applying the solder.

Killing the muriatic acid.

1505. The soldering iron, or *copper-bit*, as it is sometimes called, is represented in fig. 710. It is a forked piece of iron put into a handle and having between the prongs of the fork a piece of copper pointed as shown. It can be made wholly of iron, but copper is generally used because it does not oxidise or waste away so quickly when heated, as iron does; and it also retains its heat longer than iron. The copper tongue should be rubbed against a piece of brick, or something of the sort, immediately it comes from the fire and before it is used. This is done to re-

Soldering iron or copper bit.

move any dirt that may happen to have got about it, and which, if allowed to remain, would prevent the solder from sticking to the copper—thus, in all probability, spoiling the operation. Besides the soldering iron or copper-bit, which may be bought for about 1s. 6d. or 2s., but little else is wanted for soldering, and that little comprises an old knife for scraping clean the metal that is to be soldered, and a bottle containing a little muriatic acid or spirit of salt killed in the manner described. A handy set of appliances for soldering, in a neat box, may be purchased for 3s. or 4s. of MR. SWAN NASH, *American and Sheffield Tool Warehouse, 119, Newgate Street, London, E.C.* The box contains a soldering iron, some solder, and a bottle of Baker's Patent Soldering Fluid. The attention of amateurs is especially directed to this useful box of tools.

Handy apparatus for amateur.

FIG. 710. SOLDERING IRON.

1506. Should it be desirable for the solder not to adhere to any portion of the article, a paste must be made with whiting and water, and put about those places; this paste will harden with the heat, but can easily be removed after the soldering operation is effected.

To prevent action of solder at any particular part.

1507. Very thin sheets of metal can be soldered best by moistening the surfaces with the acid, and putting a piece of tinfoil between them, after which the two pieces to be joined are placed between a pair of hot tongs until the tinfoil is melted. This is a very simple, expeditious, and neat method of soldering thin sheets of metal.

Soldering very thin sheets of metal.

1508. In brazing, the pieces to be united are cleansed from grease, etc., in the same manner as for soldering; the pieces are bound firmly together with fine wire, or held together with a pair of tongs, and put into a clear fire. When just red-hot they must be taken out of the fire, and a few bits of soft brass and a little powdered borax put on the joint, which is then returned to the fire and kept there until the brass is thoroughly melted.

Process to be followed in brazing.

1509. One can hardly imagine it to be so, but however close the joint, if the operation is performed with a little care, the brass will penetrate quite through the seam, and, indeed, almost through the pores of the iron itself. The brass used for brazing should be tolerably soft and in small pieces. Braziers generally use what is called granulated brass, which is nothing more than melted brass dropped whilst liquid into water. When

Penetration of iron by brass.

granulated brass is not obtainable, or not at hand, brass filings will answer almost as well.

1510. For brazing very small articles the amateur will find a blow-pipe and a piece of charcoal of great assistance to him. The charcoal is fixed an inch or two from a flame, which by means of the blow-pipe is caused to impinge upon the charcoal. A great heat is thus obtainable, the article is manipulated with greater facility, and the process can be watched much better than when a common fire is used. A far more intense heat can be produced by other methods, but these require expensive apparatus, which, except for this single purpose, would be otherwise useless to the amateur.

Brazing small articles.

1511. The methods of soldering and brazing having been described, all operations in working in zinc and other sheet metals, plumbing, and gas-fitting will be more readily understood. For reasons already given, and chiefly because the generality of amateurs will never do much in this kind of work, we must confine ourselves in zinc-working to making such zinc joints as may be wanted in covering a roof, putting in the *flashing* of such a roof, and making a zinc gutter and pipe; in plumbing to stopping a leak in a pipe and joining two pieces of pipe together; and in gas-fitting to one or two simple operations that the amateur can manage without the assistance of the professional gas-fitter.

Working in zinc.

1512. Let us first see how zinc is sold, and at what price, and then pass on to the operations in zinc-working that have been already indicated. Zinc is sold in sheets 7ft. and 8ft. in length by 3ft. and 2ft. 8in. wide. It is made of different gauges or thicknesses, each gauge being distinguished by the weight of the zinc to the foot super. Thus, the gauges most used and their weights are as follows:—

Sizes and prices of zinc sheets.

Nos.	10	11	12	13	14	15	16
Weight	9oz.	11oz.	13oz.	16oz.	19oz.	22oz.	25oz.

For flats, gutters, and roofs, the best gauge is No. 15 or No. 16, on account of its weight, and therefore superior stoutness. In laying zinc, iron nails must be avoided, and the zinc must be kept from coming into contact with iron or lime, for when it does galvanic action is set up, which ultimately destroys the zinc. The best roofing zinc costs, according to "Laxton's Price Book," 32s. per cwt.; corrugated zinc, 36s. per cwt.; zinc tubing, 44s. per cwt.; zinc nails, 8d., and zinc tacks 10d. per lb. The best solder for soldering zinc costs 1s. 6d. per lb.

Joining pieces of zinc and lead.

1513. The ordinary way of joining sheets of zinc on a roof, the sheets being disposed vertically, or running from the top of the roof to the bottom, is by a joint known in plumbing as the "roll" joint; but when sheets of zinc have to be joined together at the edges, to form the lining of a box to be sent to warm latitudes or through warm latitudes, the lining of a cistern or the tray of a flower box, the edges must of necessity be soldered together in the manner already described.

The roll joint.

1514. The *roll joint*, which is used in joining sheets of lead and sheets of zinc, is made in the following manner. Suppose that in fig. 711 A is the boarding on which the zinc is to be laid, shown in section. Just where the joint is to be made, a strip of wood about 1 in. or 1½ in. square is nailed, flat on the under surface and rounded above, as at B. The sheet of zinc C is then laid on the roof, and its edge folded over the rounded wood as shown. The sheet D is then laid on, and its edge folded in the contrary direction over the edge of C. This last roll may be soldered down or kept in its place by a few tacks. The rounded form of the wood over which the zinc is bent effectually prevents the entrance of any water, even if the zinc edge E, of D, is left unsoldered. Sometimes a triangular strip of wood is substituted for the rounded strip, as shown in fig. 712.

FIG. 711. ROUND ROLL JOINT.

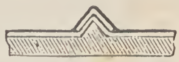


FIG. 712. ANGULAR ROLL JOINT.

Zinc need not be painted.

1515. There is no absolute necessity for painting zinc work, for exposure to the atmosphere has the effect of coating it with a thin film of oxide, which protects it from the further action of the air as effectually as paint. To prevent the water from entering between the zinc and the boarding, or the coat of roofing felt which should be laid on the boards before the zinc is put on, pieces called *flashings* are inserted into the brick-work at the part where the zinc sheeting meets the wall. Supposing one end of a zinc roof to a bay window to be represented in fig. 713 in elevation, A and B being the sheet over the central part and the triangular sheet at the end shown, connected by a roll joint at C O, it is manifest that some means must be adopted to prevent the

Zinc should be underlaid with roofing felt.

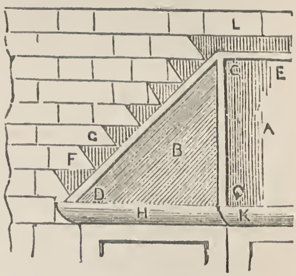


FIG. 713. FLASHINGS IN ZINC ROOF TO BAY WINDOWS.

water from getting between the brick-work and the upper edge of the zinc sheets. These are turned up over a flat strip of wood with the upper edge bevelled, as shown at C D and C E. A piece of zinc is then cut with triangular flaps as shown at F, G, etc., the upper edges of which are buried in the joints of the brick-work, the mortar being raked out to admit them. When the joints have been stopped with cement, the water that may trickle down the wall when it rains passes over the *flashing*, as it is called, the lower edge of which is turned over the strips C D, C E, and is received on the zinc sheeting at A and B, whence it trickles down to the gutter H K. A long piece of flashing, the end of which is shown at L, runs along the top of the roof, and is turned down over the strip of wood C E on to the sheet A.

Flashings in zinc work.

1516. Gutters and pipes in zinc are formed by beating the zinc into the necessary form over a shape or mould of wood, and soldering up the edges of the pipes and the ends of the gutters to prevent the escape of the water that may run into the one or through the other. The work is not difficult, though it is far from likely that the amateur will do it neatly at the first attempt.

Gutters and pipes in zinc.

1517. Suppose the amateur wants a short piece of zinc piping; he can take an old broom handle as a mould, and having beaten a strip of zinc into the necessary form round this with a wooden mallet, he has only to solder up the overlapping edges and the pipe is made; and if he wants a longer pipe he may connect two or three of these lengths by sockets of zinc just large enough to receive the ends of the pipes, soldering the whole together. To attach the pipe to a wall or boarding, a slip of zinc is soldered to the pipe itself or to the socket within which the ends of the two pieces of pipe meet, as at A in fig. 714. This strip on each side is of the length indicated by A B, that is to say, about 4 or 5 inches. Each strip is divided into two parts in the dotted line C. A stout zinc nail D is then hammered through the zinc in the part next to the pipe or socket, and the outer part is then turned over to hide the head of the nail, the attachment presenting when finished the appearance indicated at E.

How to make zinc piping.

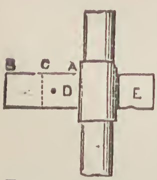


FIG. 714. ATTACHMENT OF PIPE TO WALL.

Attachment of pipe to wall.

1518. Gutters are made in the same way as pipes; that is to say, the zinc must be bent and beaten into the required form upon a wooden mould. Different patterns of zinc guttering are shown at A and B in fig. 715. The edges of the zinc should

How to make zinc gutters.

be doubled over inwards, partly to take off the unpleasant appearance of the raw edge, which is likely to scratch the hand of any one who may be clearing the gutter of dirt, leaves, etc., and partly to give more substance and solidity to the shoot. The gutters at A and B are supported on brackets screwed to the facia below the roofing, whatever the material may be. In C another useful method of attaching a zinc shoot to a facia is shown in section. A short pipe or roll of zinc, P, is soldered within the gutter between the topmost parts or edges on either side, and transversely to the length of the gutter. Holes are made in the front edge and back edge of the gutter to admit of the passage of a long and somewhat thin screw through the pipe. The screw enters the facia, and with others at intervals of about 2ft. sustains the gutter. To carry off water from a gutter a vertical pipe must be inserted as at Q, and the shoot should have a gentle fall throughout its length, from one end to the other at which the vertical pipe is attached. If the gutter be but a short one, say from 4ft. to 6ft., there is no absolute necessity to give any inclination to it.

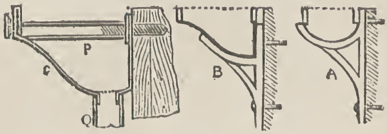


FIG. 715. ZINC GUTTERING.

Tray of zinc for lining box.

1519. The description of the method to be adopted in making a small rectangular tray of zinc, suitable for the lining of a wooden box intended to stand on the sill of a window to hold flowers, will afford a key to the mode of doing all rectangular work in zinc, such as making the lining of a cistern, etc.

How to make the tray.

1520. In describing the method to be followed in doing work of this kind, dimensions are of no importance, as it is only the mode of procedure that it is sought to show, and not how to make any particular box or tray of a certain size. The amateur can settle the dimensions according to his requirements. Having taken a sheet of zinc of the necessary length and breadth, as shown in A B C D in fig. 716, allowance being made for the turning in of the edges all round the tray, mark the zinc by lines, as shown by the dotted lines in the figure, to show the bottom, the sides, and the laps to be turned in. Now cut out the corner pieces L E K A,

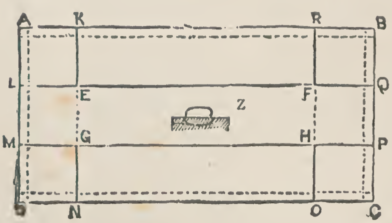


FIG. 716. BOX OR TRAY IN ZINC.

M G N D, O H P C, and Q F R B. Turn over and beat down—all the beating must be done with a wooden hammer or mallet—the edges as shown at L M, N O, P Q, and R K, by the dotted lines contiguous to these lines, and then turn up the sides of the tray round the bottom E F H G, beating them to the required inclination, which will be a right angle, over a rectangular block or bar of wood. When the edges of the sides have been brought into contact at L E to E K, F R to F Q, etc., solder them up. A wire ring, as at Z, the iron being coated with tin, may be soldered to the tray at each end, so that it may be readily lifted in and out of its wooden casing if necessary. A hole should be made in the tray at a convenient part, and a small waste pipe soldered to it to carry off the surplus water. This may be short and kept stopped with a cork, which need only be removed when the plants have been watered, a jug being held underneath for a short time to catch any water that may drain away.

General principles of working in sheet metal.

1521. All working in sheet metal is done very much in this manner; the parts must be carefully cut out and fitted, and then soldered together. Accurate marking out of the different parts of which the article is composed is most essential, and to do this well a knowledge of drawing is necessary. There are other modes of working in sheet metal, as, for instance, in tin-plate, in which the article—as, for example, a shallow tray, tart dish, or patty pan—is formed by hammering up the material over a wooden block, pliers and punches of a simple character being required to form the edges, when turned over, and the indentations that are sometimes added by way of ornament.

No special directions requisite.

1522. No special directions are required for this kind of work. A shallow rounded patty pan is formed by hammering a circular piece of tin-plate over a rounded block of wood of the pattern required. If additional strength is required at the edge of any tin vessel, it is obtained by turning the edge over a piece of iron wire and hammering it down.

Corrugated iron and zinc sheets.

1523. Our notice of working in sheet metal, sufficient for the purposes of the amateur, though necessarily brief, would be incomplete without some mention of corrugated iron and zinc sheets for the purpose of covering the walls and roofs of buildings. This material is shown in section at A, and in elevation at B in fig. 717. The metal as shown is fluted or wrinkled, whence its name, from the Latin *ruga*, a wrinkle or fold. Corrugated iron is generally *galvanised*

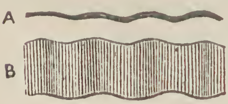


FIG. 717.
CORRUGATED IRON.

or dipped in melted zinc, to keep it from rusting under the action of the air.

Putting up the sheets.

1524. Corrugated iron and zinc can be fixed by the amateur without much difficulty. He must first put up a skeleton of wood to support the sheets, and on this skeleton or framework the sheets must be laid, being fastened to the framework and to each other. The sheets are fastened together by means of rivets passed through holes punched to receive them, and beaten down on small washers or flat rings of metal. The upper sheets should always lap over the sheets below after the manner of slates, tiles, weather-boarding, etc. They are joined vertically or at the sides by letting the outermost fold of one sheet fall into and lap over the outermost fold of the sheet next to it.

Prices, etc., of corrugated zinc and iron.

1525. Corrugated zinc is sold at the rate of 36s. per cwt. in sheets of the ordinary size. It will readily be understood that a sheet of plain zinc is longer than a sheet of the same dimensions when corrugated, because a serpentine line will not stretch over as much space as a straight line of the same length. Corrugated iron is sold in sheets of various sizes, measuring from 6ft. by 2ft. to 8ft. by 3ft. at the rate of about £1 7s. 6d. per cwt. for the thicker qualities, and about £1 5s. per cwt. for the thinner qualities. It is distinguished by gauges, which, with the weight of each per square foot, are as follows :—

No. 12 .... $4\frac{1}{2}$lbs.	No. 16 ...... $3\frac{1}{2}$lbs.	No. 20 ...... $2\frac{1}{4}$lbs.	No. 24 .... $1\frac{2}{5}$lbs.
,, 14 .... 4 ,,	,, 18 ...... $2\frac{1}{2}$,,	,, 22 ...... $1\frac{3}{4}$,,	,, 26 .... $1\frac{1}{8}$,,

The above weights must be taken as approximate only, and the prices also as merely approximate, in consequence of the variation in the price of iron at different times.

Illustration of advantage of knowing how to braze, etc.

1526. Before leaving this part of our subject an illustration may be given of the advantage of being acquainted with the art of soldering and brazing and working in sheet metal, in showing how a tin case in which meat has been contained may be converted into a petroleum lamp, which may be turned to good account for heating and other purposes, as, for example, for giving bottom heat to any contrivance for striking cuttings.

Lamp for bottom heat.

1527. Let A B C D represent the tin in section. The top of this should have been taken carefully off, the cut having been made *at the top*, just within the edge, so as to leave a firm, even, solid edge instead of a ragged one. Over this fit a new round piece of tin-plate, cut sufficiently large to admit of the edges being

turned over and soldered on to the tin. In the centre place a flat tin tube, as at E, to carry a wick, and to each edge of this tube attach flanges to carry a wire, having a small wheel in the centre working in a slot in the tube to push the wick up and down; at one end of the wire another wheel may be affixed, by which it may be the more easily turned. This contrivance is shown at F. At G there should be a hole in the cover for the admission of oil when necessary, the hole being closed by a small plate of tin working within a groove made by soldering three strips of tin-plate round the hole. By the aid of such a reservoir and lamp as this, enclosed in a biscuit-tin in which holes have been cut for the admission of air, and in which a square tin tray has been made to fit at the top to hold water, bottom heat may be conveyed to a box consisting of wooden sides with a slate bottom, resting on the top of the tray that contains the water. In fig. 719, which exhibits this contrivance in section, A A is the tin biscuit-box, B the lamp or heater, C the tray fitting into the top of the biscuit-box to hold water, D D the sides of the box, and E the slate bottom resting on ledges. A pipe should be attached to the biscuit-box as a chimney, to allow of the free passage of air through the box, without which the lamp could not be kept alight; and a small lip, projecting beyond the biscuit-box, should be added to the tray C, so that water may be poured into it when requisite without removing the box D D.

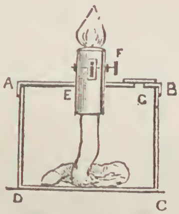


FIG. 718. TIN LAMP.

Contrivance for application of bottom heat.

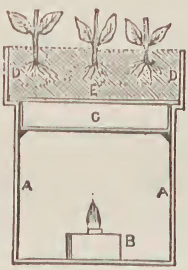


FIG. 719. CONTRIVANCE FOR STRIKING CUTTINGS.

1528. In plumbing and gas-fitting, as it has been said, there is very little that the amateur can do. He may learn how to join two pieces of lead pipe together, and how to solder two pieces of gas pipe together, and he may go so far as to screw gas-fittings together; but in this a small amount of instruction and two or three hints and suggestions will be all that can be given, and, indeed, is all that is required. The slight knowledge of plumbing that may be gained will be useful in constructing fountains and similar contrivances for the embellishment of the house or garden. In gas-fitting the amateur is advised to do very little, or even nothing, but to leave such work to the professional gas-fitter; for with escapes of gas the consequences involved, through carelessness or

Plumbing and gas-fitting.

accidental ignition of the gas, are sometimes terrible, causing destruction of property and even of life.

1529. A joint in plumbing is different in form to that used in joining pieces of sheet metal. When two pieces of pipe of equal thickness are to be joined together, the edges must be scraped clean, and a little tallow rubbed over them. The joint is then held in such a manner and gently turned so that melted solder may be poured all round it. The plumber then works the melted solder round the joint, and presses it on all sides with the soldering iron, so as to smooth it down and render the surface perfectly even. The joint thus made swells round the junction of the pieces of pipe on all sides in an egg-shaped form. The ordinary plumber's joint is shown at A in fig. 720. At B a joint is shown in which the under piece has been slightly enlarged by working a stick round the orifice, or knocking a small cone of boxwood into it, while the edge of the upper piece is scraped away a little, so that it may fit into the piece below; the joint is then finished as before. Sometimes, when there is no side-strain on the joint, as in a pipe running down the angle of a room, the bell-shaped orifice of the lower portion is made a little larger. The upper part of the pipe is then dropped into its place, the solder run into the space, and the joint made by passing the heated iron round the ring of solder. In C, a pipe of smaller bore is inserted into a larger one; in this case nothing more need be done than work some solder round the edge of the larger pipe where it laps over the smaller one. In each illustration the pipes and the joint are shown in section.

Joint in plumbing; how to make it.

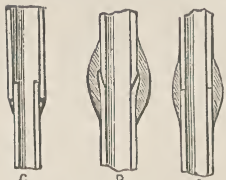


FIG. 720.
JOINTS IN PLUMBING.

1530. With regard to gas-fitting, the edges of the pipes, if they be of iron, are put together by screwing the ends of the pipes to be connected into a piece of iron-pipe or socket about 2in. long. With connections of this kind, specially made for the purpose, pipes may be joined together at right angles, or three pipes may be brought together by means of a T joint, by which two of the pipes are joined in the same straight line; the third proceeding from the point of junction at right angles to the other two. The screw of every pipe that enters another by means of a female screw should be smeared with white lead before it is put in. This should be done whatever may be the material of which the pipe is made, or whatever may be the joint

Connecting sockets for pipes of iron.

Application of white lead to joint.

Even gas-burners should be treated in this way. The white lead renders the joint impervious to water, air, and gas.

1531. Lead pipes, and the pipes of composite metal used in gas-fitting, are joined like the larger kinds of lead pipes, the joint generally used being that shown at B in fig. 720. A smaller copper bit is used for small gas piping, and a softer kind of solder, as the composite metal melts at a comparatively low temperature. This solder is used expressly by gas-fitters, and is called gas-fitters' solder. These pipes may be secured or soldered to taps and connections of all kinds in the same manner. The joint made in gas-fitting need not be so large and clumsy as the ordinary plumber's joint; indeed, but little solder is required in making a joint in gas piping.

Lead and composite pipes for gas.

How to join them.

Fitting to taps, etc.

1532. It must be borne in mind that in plumbing and gas-fitting a joint cannot be made unless the piping is perfectly dry. Therefore in attempting any repairs of lead water-pipe, the water should be turned off at the house main, a tap usually placed within the house just at the spot where the service pipe enters it and comes into view; the gas should be turned off at the main. Time should then be given to the pipes to dry. This can be assisted by a little heat near the spot it is desired to dry. When a pipe is cracked by frost or otherwise injured, it is useless to attempt to stop the slit or hole until the pipe is dry. As soon as this is the case, the crack or hole may be filled up with solder, or, what is far better, the pipe may be cut, the broken part removed, and the ends joined together again.

Lead, etc., must be dry when joint is made.

1533. In addition to the solders already given, it may be useful for the amateur to know that the lining of tea-chests makes a good solder for tin-plate goods, being made of tin and lead in about the proper proportions; that is to say, two parts of tin to one part of lead. For soldering pewter, from one to three parts of bismuth should be added to solder for tin. Plumbers' solder is made of equal parts of lead and tin. Equal parts of copper and zinc melted together makes a good solder for brass. Glaziers' solder, for joining strips of lead to form lead casements, is made of three parts of lead to one part of tin.

Lining of tea-chests good solder for tin.

Plumbers' and glaziers' solders.

1534. Some people have an idea that it is possible to solder or braze without heat. It may be *possible* to do so, but the *probability* is that if the amateur made a hundred attempts he would fail in ninety-nine. He had better therefore not attempt

Soldering without heat.

anything of this kind, but follow up the ordinary methods of soldering and brazing with heat in the manner described above. Directions for soldering without heat are given in Spon's "Workshop Receipts," and that the amateur may not be without knowing one way by which it is said that this can be effected, we have transferred it to our pages.

Useful recipe for doing this.

RECIPE.—"*Soldering without heat.* Take 1oz. of ammoniac and 1oz. of common salt, an equal quantity of calcined tartar, and 3oz. of antimony pound well together and sift. Put this in a piece of linen, and enclose it well round with fullers' earth, about an inch thick; let it dry, and then put it in one crucible covered by another crucible over a slow fire to get hot by degrees; keep up the fire until the contents of the crucible get red-hot and melt. Then let it cool gradually, and when cold pound the mixture. When you wish to solder anything, put the two pieces you want to join together on a table close to one another. Make a crust of fullers' earth, so that passing under the joint and holding to each piece it shall be open at the top. Then throw some of the powder (that has been prepared as described above) between and over the joints. Dissolve some borax in some hot wine, and with a feather dipped in the solution rub the powder at the place of joint—it will immediately boil up. As soon as the boiling stops the consolidation is made. The calcined tartar is made by placing crude tartar in a covered crucible and raising it to a low red-heat. Allow it to cool gradually."

Brazing iron, etc., without heat.

1535. The following recipe for brazing steel and iron without heat is also taken from Spon's "Workshop Receipts":—

Recipe for the process.

RECIPE.—"To braze steel and iron without heat. Take ¼ oz. of fluoric acid, 2oz. of brass filings, and 1oz. of steel filings. Put the filings into the fluoric acid, touch each part of the work with the mixture, and put them together. Take care that the fluoric acid is put into an earthern vessel."

Mending, etc., that may be done by amateur.

1536. The chief practice that the amateur will get in soldering will most likely be in stopping leaks in tea-pots, coffee-pots, tin saucepans, etc., that would otherwise be handed over to the itinerant tinker; unless he takes to make such contrivances for striking cuttings as we have already described in this chapter, or to construct fountains and other kinds of waterworks on a small scale.

Tools, etc., required.

1537. The tools and the materials that are wanted have been already described, but it will be as well to remind the amateur that these consist of a soldering iron and an old knife for scraping the metal that has to be soldered, some solder,

which may be bought at the ironmonger's or plumber's, and some muriatic acid or spirits of salt in a bottle properly killed, or a piece of sal ammoniac and a lump of resin. These being placed ready to hand, and the soldering iron put in the fire to heat, the next thing is to inspect the damage done to the injured vessel, which may have had its spout or handle melted off, or which may leak through holes, smaller or greater as the case may be.

Description of process.

1538. Suppose, first of all, that the damaged article is a coffee-pot, and that the damage done to it consists in the spout having become unsoldered by getting in a flame when placed on the fire. The edges of the separated parts must be scraped clean, and dressed with muriatic acid or sprinkled with resin. The parts to be united are then held close together, and some solder run round the joint by applying the end of a stick of solder to the hot point of the copper bit, whose heat will melt the solder and cause it to flow nicely round the joint. Again, suppose that the article to be mended is a saucepan, and that the saucepan leaks. If the leak be too small to be easily detected with the eye when looking over the article, some water must be placed in it, and the places at which the water issues must be carefully marked. In any case, the black crust which has gathered on the saucepan, through long acquaintance with the fire, must be carefully scraped off, so as to render the saucepan as bright and clean as may be in this particular part. If there be but one or two small holes, the saucepan may be made useful again by spreading a drop of molten solder over and round the hole or holes. This will be sufficient to mend small holes no bigger than those which may be made with the point of a pin in a piece of paper; if, however, the holes be too large to be stopped with a bit of solder, and they occur in three or four places tolerably near to one another, the best thing to be done is to lay a new piece of metal of sufficient size to cover all the holes, and reach a little beyond them. The piece may be cut of the shape required from any old canister that the amateur may have, and for this reason it is as well for the amateur to save all the canisters of this kind and tins that may come into his possession. The cutting is easily effected by a pair of shears or strong scissors, kept for this purpose. After marking the place where the patch is to be put on by means of a scribe, scrape the metal perfectly clean to the extent of ¼ or ⅜ of an inch on each side of the mark. Now clean the soldering iron, which has been heated in the fire, place it on the bit of sal ammoniac and bring the solder in contact with it, when the solder will

Scraping metal and applying acid.

Putting piece over hole.

melt and cover the end of the copper bit, making it as bright in appearance as tin plate. Replace the bit in the fire, or in such a position with regard to the fire that it may be kept hot for use when wanted, and then lay the new piece of metal on the saucepan in the position in which it is to be fixed, and which has been sufficiently indicated by the mark made by the scribe. The saucepan may be touched with muriatic acid along the line where the joint is to be made, and the new piece as well, or a little fine powdered resin may be sprinkled along the joint. A little of the solder may now be melted along the joint by means of the bit, and the solder should be drawn along the edges until the joint is complete and perfect in every part. When the solder has cooled, which it will do very quickly, the vessel may be filled with water to see if the work has been properly and effectually done.

Running in solder.

1539. Bell-hanging and wire-working may be fairly included in this chapter on working in sheet metal, as the material used is metal, though in a different form. The appliances required are also different. In bell-hanging no soldering is required, but in wire-working soldering will be sometimes found useful in uniting the ends of a piece of wire so as to form a circle. A neater joint is made in this way by filing down the wire and fitting the surfaces together for the length of an inch or two, than by twisting them together or by the usual plan of forming a loop at each end of the wire, thus hooking the ends together.

Bell-hanging and wire-working.

1540. In bell-hanging the tools required beyond what the amateur may already have in the shape of hammers and chisels for lifting floor-boards and removing skirting-boards, and a screw-driver for fixing these in their places again by means of screws, are pliers for turning, twisting, and cutting the wire, and two or three long gimlets, from 2ft. to 3ft. long, for boring a passage for the wire from one floor to another. This is only required in old houses, or in new houses in putting up bell furniture in rooms where no provision has been made for bell-hanging. It is usual in building a house in the present day to provide for the passage of the bell wires from floor to floor by inserting bell-tubing in the walls. This tubing is buried in the plaster, and the wire can be passed down it at pleasure without doing any injury to the walls. Even in an old house, when undergoing thorough repair, it is advisable to insert bell-tubing by cutting a channel for it in the plaster, if the walls be plastered, and filling up the depression and hiding the bell-tubing with

Tools required in bell-hanging.

Long gimlets.

Tubing in walls for reception of wires.

some fresh plaster. Bell-tubing is sold at from 6d. to 7d. per lb., or by the foot, copper tubing costing 8d. per foot, and zinc tubing 4d. Bell pliers cost from 2s. to 3s. each, and bell gimlets from 1s. 6d. to 3s. each, according to length and quality.

Cost of tools and appliances.

1541. Bell-hanging, perhaps, is the most expensive work done in the house when viewed in relation to the materials and fittings used. Much trouble, care, and consideration is involved in bell-hanging, so that the bell may work easily. To this end the position of the bell, the handle by which it is set in motion, and the course taken by the wire should be duly considered, the course of the wire being arranged so as to avoid angles wherever it is possible to do so; because wherever the direction of the wire is changed a crank is necessary, and for every additional crank more power is required to set the bell in motion.

Bell-hanging expensive work.

1542. For hanging a bell complete with copper wire, cranks, etc., the charge varies from 10s. to 15s., or even more, according to the length of the wires and the distance of the bell from the handle by which it is pulled. The bell itself may be bought at from 1s. 6d. to 2s. 6d. per pound, and the bell furniture at all prices according to quality, the materials of which it is made, and the amount of decoration bestowed on it. For example, lever pulls in plain white, buff, or black porcelain cost from 1s. to 1s. 3d. each; in brass from 1s. to 7s., and in china, painted, from 3s. 6d. to 13s.; in glass, from 4s. 9d. to 13s.; and in wood, from 4s. 6d. to 10s. 6d.; furniture with ivory mountings costing 14s. or 15s. Copper wire for bell-hanging costs from 1s. to 1s. 6d. per lb., T plates 1s. 9d.; and cranks—of which there are different kinds, distinguished as pillar, mortise, purchase, leader, and end and side-driving cranks—from 10d. to 2s. 6d. each, the purchase cranks being the most expensive. Flat mounted wheels and chains attached to the bell-pull, and mortise mounted wheels and chains cost 1s. 3d. each, but pillar wheels and chains are 1s. 9d. single and 2s. 6d. double. Bell-staples for pinning the wire to the wall or carrying it along joists cost from 4d. to 9d. per gross.

Cost of bell, etc., complete.

Cost of various appliances.

1543. The kinds of cranks to be used, and the direction to be taken by the wires depend entirely on the position of the room in which is the bell-pull, with reference to the board on which the bells are hung, and which is fixed, generally speaking, either in the kitchen or in the passage without, just above or opposite to the kitchen door. Unless the direction taken by the bell be the simplest possible, the amateur had better have recourse to

Cranks and direction of wires.

a professional bell-hanger to do the work, for he will not understand what cranks to use; and unless the course that the wire is to take is known, it is utterly impossible to give any practical directions with regard to cranks, etc., that would be of service to him.

1544. Let us consider the case in which a bell-pull in a sitting-room moves a bell fixed over the kitchen fireplace in the kitchen below. In

Illustration of process.

this case, as the wall of the sitting-room is merely a continuation upwards of the wall of the kitchen, the wires by which the bell is moved lie all in one plane; there are, indeed, but two pieces of wire required, and these are at right angles to one another. First, let us look at the bell-pull or handle by which the bell is set in motion. This is shown in fig. 721. In this figure, D is a circular plate, with a rim part way round it, working within another rim of less depth. A lever A, with a knob B at one end by which it may be pulled or moved, is fastened to the

Bell-pull or handle.

plate D by a screw C, passing over a peg X in the centre on which the plate D works, and which has a screw at its outward end on which an ornamented boss or plate is screwed, covering and hiding the interior of the pull—namely, the plate D and the pivot H—on which the plate and lever work. Fastened to the lever A, or to the rim of the plate D, is a flat chain E, which, when the lever A is pulled down, is brought upwards and backwards on the rim of the plate D. The end G of the chain passes into the tubing in the wall, and to it is attached the wire W. The lever A can be moved downwards in the direction shown by the arrow until it meets the flange or rim F, which checks its further progress; the other end of this flange prevents it from doing more than return to its original upright position when released.

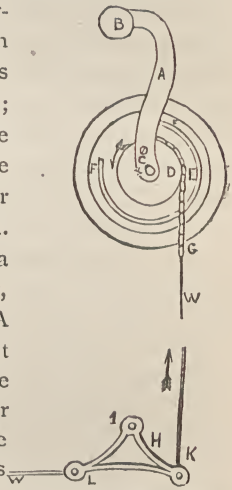


FIG. 721. BELL PULL OR HANDLE.

1545. The wire W passes down the tubing and out through the ceiling of the kitchen, and here it is necessary to change its direction

Tubing and wire: change of direction of wire.

from a vertical to a horizontal course. To do this a crank is necessary, which is a triangular piece of brass, having a hole at each angle. The crank is shown at H. It works on a pin or pivot passed through the hole I, and inserted in the wall or a piece of brass fixed to the wall to carry the crank. The other

end of the wire W, fastened to the chain at G, is passed through the hole K. The wire is fastened by twisting the end round the other part of the wire. It must not be stretched too tightly, but on the contrary hung somewhat loosely, or there will not be sufficient play for the wires and crank, and the bell will only be rung with difficulty. When the bell is pulled, the wire W is pulled in an upward direction as shown by the arrow, and the corner K of the crank is raised. Bell wire should always be stretched before it is used. To do this, one end should be attached to a loop or stove bar, and the wire pulled gently with a pair of pliers. Wires of gauges 16, 17, and 18, are most generally used for house bells, and Nos. 14 and 15 for out-door purposes.

Crank and tension of wire.

1546. In fig. 722 the bell itself and the mode of hanging it is exhibited. A is a ⊤ plate of brass, fastened to the wall by nails, as shown in the illustration, or otherwise attached by screws to the wooden bell board. To the ⊤ plate a lever arm B is attached, working on a pivot at X; and to the topmost end of the lever, opposite to the pivot, is fastened one end of the wire W, the other end of which is attached to the corner L of the crank H, in fig. 721. To this end of the lever is also fastened one end of the coiled wire spring S, which is nailed to the wall at T, and whose action keeps the bell in motion for a short time after the bell-pull has been released from the hand of the person who rung it. Round the pivot X passes the loop of a flat coiled spring C C, to the other end of which the bell is attached. From the arrangement of the cuts—which are placed so as to show the handle, the connecting wires, and the bell in their relative positions—it will be evident that when the handle is pulled the first wire is pulled upwards, bringing up the end or corner K of the crank H. The upward motion of the crank, working round the pivot I, pulls forward the angle L. This jerks the lever arm B at the other end of this second wire, and the bell being set in motion sounds. By the stretching of the wire in the direction of the arrows, the spring S, which is fastened to the wall at T, is pulled out. As soon as the handle is

Bell and mode of hanging it.

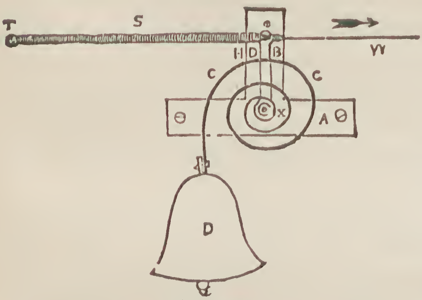


FIG. 722.
BELL, AND MODE OF HANGING IT.

How the bell is sounded.

released and the tension on the wires is removed, the spring recoils, imparting additional motion to the bell, and prolonging its ringing. As long as the bell is in a working condition, the handle A of the bell-pull will remain upright; but if any of the wires get broken, or slackened to too great an extent, the handle falls towards F, showing that the bell is out of repair and ought to be seen to. If it is only through the slackening of a wire, the end of the slackened wire may be untwisted with the pliers, drawn a little farther through the loop of the crank, and then twisted up again.

Bell and wires out of order: how indicated.

1547. A slight knowledge of wire-working will perhaps be more useful to the amateur than acquaintance with the principles of bell-hanging, for with a file, a gimlet and bradawl, and a pair of pliers for turning wire, there are many useful bits of work that can be done for the house and garden. For example, hanging-baskets for greenhouses, conservatories, and windows in which plants are kept, can be easily made; wire trellis for walls, supports flat and circular for flowers—such as musk, fuchsias, and sweet-peas—and sieves for sifting mould and ashes.

Knowledge of wire-working desirable for amateur.

What can be done in wire-work.

1548. Wire of copper, iron, and brass is made in all sizes, from the thinnest binding wire to about ¼in. in thickness. When the diameter is larger than this, it can no longer be considered as wire, but is spoken of as a rod, whatever may be the metal of which it is made. The stoutest wire that the amateur will require will be about ⅛in. in thickness, or a trifle more, and this will be chiefly used for imparting strength and solidity to wire-work, as will be seen presently. He will also want wire of various gauges, from $\frac{1}{16}$in. to $\frac{1}{32}$in. in diameter, and fine binding wire for securing transverse wires—that is to say, wires that cross each other at any angle, one to the other. The best kind of wire that can be used for binding is fine copper wire, because it is more pliable than brass or iron wire, and is therefore less brittle, and can be more easily bound round the wires that it is used to fasten together. For purposes where strength is not so much an object, the wire used for decorative purposes, such as binding evergreens to a rope to make a garland, is tolerably serviceable.

Sizes and prices of wire.

1549. The gauges of wires are expressed by numbers, and range from No. 1, which is a little over ¼in. in diameter to No. 26, which is the very finest wire made. It may be said that No. 2 is exactly ¼in. in diameter, and that No. 23 is the bind-

Gauges of wires.

ing wire ordinarily used for light purposes. The gauge of any wire may be ascertained by means of the Birmingham Wire Gauge, a useful instrument, the price of which is 6s. 6d. A circular folding gauge for the pocket may be obtained for 6s. All wire except fencing wire is sold by the pound, copper wire being 1s. 2d. per pound; brass wire, 1s. 4d. per pound; and iron wire, 4d. per pound.

Galvanised fencing wire.

1550. Galvanised fencing wire will be found useful for making fences, especially to separate a lawn or garden ground from pasture land for cattle, when it is desirable to have nothing that may break the view, as a wall, hedge, or paling. This kind of wire is also sold in gauges; these, with the number of feet to the cwt. and the price per cwt., being as follows:—

			£ s. d.				£ s. d.
No. 1	Gauge, about	174ft. to cwt.	1 12 0	No. 5	Gauge, about	344ft. to cwt.	1 12 6
No. 2	,,	219 ,,	1 12 0	No. 6	,,	413 ,,	1 12 6
No. 3	,,	245 ,,	1 12 0	No. 7	,,	483 ,,	1 13 6
No. 4	,,	288 ,,	1 12 6	No. 10	,,	895 ,,	1 16 6

How to put up wire fencing.

1551. To fix fencing of this kind, stout posts are required at either end, with spurs or struts to enable them to withstand the strain of the wires. The intermediate posts may be slighter in size. The way in which such fences may be put up is shown in fig. 723.

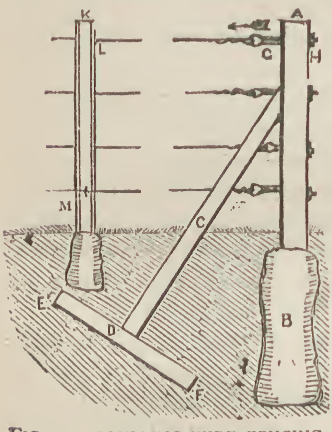


Fig. 723. Posts for wire fencing.

Straining posts and struts.

In this, A is the end or straining post, sawn out of fir or oak, but having the slab wood left on at the bottom at B to give it a better holding in the ground. It is manifest that when the wires are tightened the strain of the upper wires will have a tendency to drag the top of A in the direction shown by the arrow. To resist this, a strut, C, is placed in the position shown, one end of which butts against the straining post A, while the other rests on a stout piece of timber D. The pressure of C against D, caused by the strain of the wires, is distributed all over the surface of the board D, instead of being concentrated at the spot where C rests on D, and is met by the resistance of the earth below from E to F.

Straining and tightening wires.

The wires are tightened by means of bolts, such as are shown at G, with a loop at one end, and a nut and screw at the other. The wire is drawn as tightly as possible through the loop, and secured by twisting the projecting end round

the wire. The nut H is then turned up, the screw of the bolt which is gradually brought forward tightening the wire. The lighter intermediate post is shown at K, and the wires may be passed through holes made in the post to receive them as at L, or pinned down to the exterior of the post with a staple, as at M. Bolts may be used at each end of the wire, but if the fencing be short one set of bolts will be sufficient; the other end of the wire being looped and passed through the post, a stout nail or piece of iron rod is passed through the loop to prevent its withdrawal.

How to fasten wire loop.

Intermediate posts.

1552. Wire is now extensively used for horticultural purposes, and wire netting is useful for making poultry houses, and for keeping cats out of the garden. Cats cannot climb over wire netting; it cuts their feet. Whenever netting is used for this purpose, care should be taken to have the netting high enough to prevent them from jumping over. Fine netting is also useful for a protection to glass in greenhouses, especially when near a road or street; for boys will be boys, and throw stones as long as there are stones lying about convenient to the hand for throwing. Excellent wire netting, and all kinds of wire and appliances for wiring walls, are supplied by MESSRS. J. J. THOMAS AND CO., *Paddington Iron and Wire Works*, 285 *and* 362, *Edgeware Road*, *London*, *W.* This firm allows a discount of from 5 to 10 per cent. on all cash purchases, according to the articles purchased, and will send an illustrated price list to any address on application. It may be well to note that every description of horticultural wire-work, such as garden arches, pea and seed guards, pea trellises, etc., are supplied by Messrs. J. J. Thomas and Co.

Wire for horticultural purposes.

Its various uses and application.

1553. The usual widths of the galvanised netting kept in stock are 12in., 18in., 24in., 30in., 36in., and 48in. A 2in. mesh is kept in stock 72in. wide. This will be found very convenient for erecting poultry yards. The prices per lineal yard 24in. wide, according to size of mesh and the strength of wire used, are as follows:—

Galvanised netting: widths and prices.

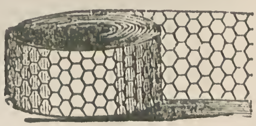


FIG. 724.
WIRE NETTING.

Mesh.	*Light.* s. d.	*Medium.* s. d.	*Strong.* s. d.	*Extra strong.* s. d.
2 in.	0 2½	0 3¼	0 4	0 5
1⅝ ,,	0 3	0 3¾	0 4½	0 5½
1½ ,,	0 3¾	0 4½	0 5½	0 7
1¼ ,,	0 5½	0 7	0 9	1 0
1 ,,	0 7	0 8½	0 11	1 3
¾ ,,	0 9	0 11	1 2	1 6

Widths other than 24in. are charged at proportional prices. Soft

galvanised tying-wire for connecting the netting may be had at 6d. per pound; and cutting-nippers, very useful for cutting wire netting, at 1s. 3d. per pair.

Straining wire along walls.

1554. The mode of straining wires along the face of brick or stone walls, wooden palings, etc., to afford support to the branches of trained fruit-trees, is sufficiently apparent from fig. 725, and will need no detailed description. The following prices give the total cost of each line of wire, including hold-fasts shown at A, straining-bolt shown at B, intermediate guiding-eyes something like the hold-fasts, and set in the wall along the course of the wire 10ft. apart, and galvanised wire of the best quality :—

Necessary appliances.

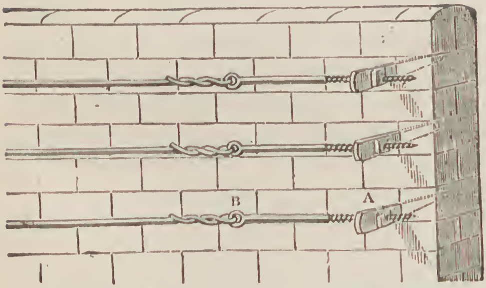


FIG. 725. WIRE ON WALL FOR FRUIT TREES.

Length of wall.	20*yds.* s. d.	40*yds.* s. d.	60*yds.* s. d.	80*yds.* s. d.	100*yds.* s. d.
No. 14 gauge wire	1 0	1 7	2 1	2 7	3 1
,, 13 ,,	1 2	1 10	2 5	3 0	3 7

Articles made in wire.

1555. Returning from this digression on horticultural wire-work and the manipulation of wire, it may be useful to show the method to be adopted in making one or two articles partially or entirely of this material, and for this purpose we will select a garden sieve and a circular trellis for sweet-peas and other climbing plants, or rather plants which require support. To these may be added a basket for a hanging plant in a conservatory.

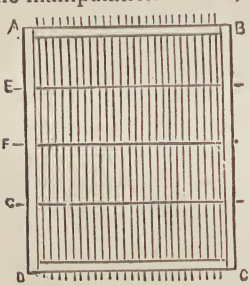


FIG. 726.
GARDEN SIEVE (PLAN).

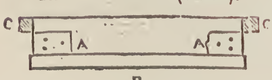


FIG. 727. GARDEN SIEVE (END).

Garden sieve: how to make it.

1556. For the *garden sieve* a square or rectangular form will for obvious reasons be found most convenient to the amateur. A square frame, shown in plan in fig. 726, must first be made. This should be of ¾in. stuff, nicely planed down and dovetailed; or, if merely nailed together, secured by iron plates bent at right angles similar to those used to strengthen common wooden boxes. These plates are shown at

A A in fig. 727. The frame being made, pass three stout wires from $\frac{1}{8}$in. to $\frac{3}{16}$in. in diameter through it from side to side as at E, F, and G, at distances of about 3in. apart, and then pass smaller, but yet strong and stout, wires from end to end, and *within* the larger wires as shown in the illustration. The distances between these wires may vary from $\frac{1}{4}$in. to $\frac{1}{2}$in., according to the nature of the stuff to be sifted. The ends of the thick wires need not project beyond the outside of the frame, as there will be some difficulty in turning the ends and beating them down; but the ends of the thinner wires should project about $\frac{1}{2}$in., and be turned and beaten down on or even into the wood. The thin wires should then be attached to, or bound down on, the thicker transverse wires with a piece of copper wire. The binding is effected by passing the copper wire once over each thin wire to bring it down to the thick wire. When the ends have been beaten down they may be concealed and a neat appearance imparted to the sieve by nailing a ledge all round the bottom as at B in fig. 727; and for convenience in holding the sieve when in use, cleats may be nailed along the sides as at C in the same figure. The cleats should only be on two opposite sides, and these should be the sides through which the thick wires pass, or which, in other terms, are parallel to the thinner wires.

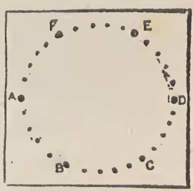


FIG. 728. BOARD FOR CIRCULAR PEA-TRELLIS.

1557. For the *circular pea-trellis*, which is made entirely of wire, a different mode of procedure must be adopted. First of all, two pieces of thin board, as shown in fig. 728, must be taken, and circles marked on them. Holes at equal distances from each other must be made in the circle marks; larger at A, B, C, D, E, and F, for the reception of larger, stouter wires, and smaller at all the intervening holes to take the smaller wires. When the holes have been made the wires should be passed through the boards A B, C D, as shown in fig. 729, the thicker wires being cut longer than the thinner ones that they may be thrust into the ground. Before the ends of the wires are passed through the boards, three or four hoops of wire made a little easier—that is to say, a mere trifle larger than the circles on the boards, as shown in fig. 728—should be passed over and outside the wires. These hoops must

Circular pea-trellis.

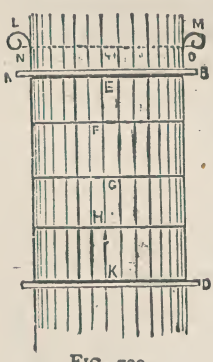


FIG. 729.

be placed, one just below the board A B in fig. 729, one just above the board C D, and the rest at equal distances up and down the wires, as at E, F, G, H, K. The horizontal wires must then be bound to the perpendicular wires with binding wire, after which the boards must be removed by gentle pressure. After this an ornamental appearance may be given to the trellis by turning the tops of all the wires outwards, as shown at L and M. This is easily done with a pair of pliers. To keep the curled ends equidistant and in their places, a circle of wire may be dropped over the ends, as shown by the dotted line N O, and secured to them by binding wire.

1558. In making a trellis of strong wire for the greenhouse or conservatory for climbing plants, a strong wire frame, as shown in fig. 730 at A B C, must first be made, and it will be convenient to keep this in its place by pinning it down to a flat surface, but not so tightly that it cannot be raised for about ¼ in. from the surface to which it has been fastened down. The frame or the boarding on which it is laid must then be spaced out so as to bring the wires that form the trellis work at equal distances from one another; and the wires, so as to impart firmness to the trellis, must be interlaced under and over each other alternately, and their ends turned in a loop over the frame and beaten down. When every wire has been put in its place the trellis is complete, and the pins or staples that hold the frame down may be removed. It is almost unnecessary to say that the frame must be made precisely the size of the space that the trellis is intended to cover.

Wire trellis for greenhouse, etc.

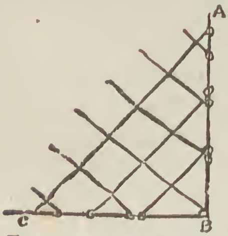


FIG. 730. WIRE TRELLIS FOR GREENHOUSE.

1559. With regard to hanging-baskets for conservatories, etc., the mode of operation is somewhat similar to that described above for making a circular trellis for plants requiring support. The shape of the basket having been decided upon, some circles of the requisite size must be made to serve as foundations of the work, to which transverse pieces must be bound, forming the bottom and sides of the basket. Three or four long pieces of wire, one end of each of which is linked on to the topmost circular wire of the basket, and the other attached to a ring or other contrivance, must then be added to provide for the suspension of the basket. The ingenuity of the amateur will suggest many other ways of forming flat and circular trellis work for plants in pots.

Hanging-baskets.

1560. All wire-work, unless the wire be galvanised, should be painted

We are now speaking more especially of iron wire used for garden trellis work, etc. Ordinary oil paint of the colour desired may be used, but the following, which is taken from Spon's "Workshop Receipts," will be found an excellent paint for wire-work.

Wire-work not galvanised should be painted.

RECIPE.—"*Paint for Wire-work.* Boil good linseed oil with as much litharge as will make it of the consistency to be laid on with the brush; add lampblack at the rate of one part to every ten by weight of the litharge; boil three hours over a gentle fire. The first coat should be thinner than the following coats."

Good paint for wire-work.

1561. It is often necessary to coat iron and wire-work with black varnish, which gives it a glossy hard surface. Stoves, the handles of doors, especially latches, brackets, and any iron article from which the original covering of varnish has been removed, or which shows signs of damage and rust, may be easily and quickly renovated in this way. The most suitable black varnish for this purpose is the Brunswick Black manufactured and sold by MESSRS. GOODALL, BACKHOUSE AND CO., *White Horse Street, Leeds.* The iron should be warmed before the Brunswick Black is applied, and when coated with the varnish should be left in a warm place to harden.

Black varnish for wire.

CHAPTER X.

PAINTING, GRAINING, STENCILLING, STAINING, VARNISHING, AND GILDING.

Protection of Wood, Iron, etc., from Effects of Weather — Subjects for Consideration—Decorator's Work—Paint should be Bought Ready Mixed—Price of Paint supplied by Oil and Colourman — Advantages of Mixing one's own Colours—Requisites for Mixing Colours—Muller and Palette-knife—Prices of Palette-knives—Colouring Matter—Boiled Linseed Oil—Average Prices of Materials—Description of Process of Mixing—Turpentine and Oil—Gold Size—Patent Dryer—Various Kinds of Dryers—Brushes used by Painters—Dusting Brush—Ordinary Paint Brush—Sash Tools—Process Followed in Painting—Cleaning Wood and applying Knotting in New Work—Priming, or First Coat—Clear-cole—Application of Second and Following Coats—Painting Old Work—Old Work must be well Cleaned—Preparations for New Coat—Composition of Paint for Old Work—Roughness of Surface—Removal of Loose Paint—Removal of Paint from Old Work—Paint Softened by Heat—Other Modes of Removing Old Paint—Apparatus for Application of Heat—Plaster requires more Paint than Wood—Process of Painting Plaster—Flatting: how managed—How to keep Paint Moist in Pot—Brushes in Use must be kept in Water—Washing out in Turpentine—Composition of Paint for Different Coats—Terms for Combinations of Coats—Colouring Substances—Charlton Zinc White—White Lead injurious to Health—Arsenical Colouring Matter—Classification of Pigments—Table of Simple Colouring Substances—Table of Compound Colours—Paints ready Mixed in Cans—Specimens of Colours—Pulford's Liquid Magnetic Paints Graining and Marbling—How Graining is Done—Marbling, and How to do it —Various kinds of Marbles—Leather and Metal Graining Combs—Graining Rollers—Grounds for Different Kinds of Wood—Graining can only be Learnt by Watching the Operation—Painting in Distemper—Scene Painting—Distemper as Applied to House-painting—To Stop Absorption of Plaster—Laying on Distemper Colours—Size of Good Quality Necessary—How to Make Good Size—Composition of Distemper Colours—Stencilling—Stencil Patterns: where to get them—Design for Stencil Work—Staining and Varnishing—Stephen's Stains for Wood—Advantages of these Stains—Operations in Process of Staining Wood—Application of the Stain—Sizing Stained Wood—Second Coat of Size—Modifications of Staining Fluids—Stains for Ebony, Wainscot, etc.—Staining Powders—Appliances used in Painting must be kept Clean—Varnishes, and Recipes for Making Varnishes—Gold Varnish—Copal Varnish—Best white hard Spirit Varnish—Black Varnish for Metal—Paint Work Improved by Varnishing—Brushes should be well Washed after using them—Polishing, and Recipes for Polish—French Polish—Naphtha Polish—Shell Lac Polish—How to Apply Polish —Elbow-grease Necessary—Finishing off Polish—Caution in use of Naphtha, etc. —Polishing Mahogany, etc. — Mixture for Stopping Holes — Gilding: how described—Gold Leaf: its preparation—Sold in Books—Mordants or Size—Tools

required in Gilding—The Cushion: how to make it—Knife and its use—Oil Gilding and Water Guilding, why so distinguished—Procedure in Oil Gilding—Japanner's Gold Size—Process of Water Gilding—Judson's Gold Paint—Purposes to which it may be applied—Artists' Black or Ebony Enamel.

1562. All that has hitherto been said with regard to operations in the building trades, or very nearly all of it, may be said to be ultimately connected with construction, but this and the following chapter will refer chiefly to decoration. It has long been found necessary to protect wood and iron from the ill effects of moisture by a hard exterior coating impervious to wet; and hitherto the best preservatives have been found to be paint and varnish, through which no wet can penetrate as long as they remain in a sound state.

Protection of wood, iron, etc., from effects of weather.

1563. The subject matter of this chapter may be devoted to a consideration of the following subjects: first, how to make or mix paint; secondly, the brushes and tools used by painters in applying paint to the surface to be painted; thirdly, graining and the higher branches of house painting; fourthly, the art of stencilling, and how it is managed; fifthly, the method of imitating various woods, and improving the appearance of deal and other woods used in house building; sixthly, varnishes, their composition and the various purposes for which the different kinds may be used; and, lastly, the modern appliances and preparations used in gilding.

Subjects for consideration.

1564. In each of these branches of the painter's trade only such points will be touched on as are likely to prove decidedly useful to the amateur. Nothing will be said about the work of the decorator, which, generally speaking, requires considerable taste and artistic power. To decorate walls and ceilings effectively a man must be rather an artist than an artisan, and any attempt to describe the manipulation necessary to impart good effect to such work will be altogether foreign to our purpose.

Decorator's work.

1565. Although it is much better and cheaper to buy paints and varnishes ready mixed, it may be as well, for the benefit of those who feel desirous of mixing their own colours, to give a few directions which will enable them to do so. One very good reason why the amateur painter should buy his colours ready mixed is that the paint which he makes himself, generally speaking, takes a very long time to get thoroughly dry and hard; and sometimes, even after the lapse of several weeks the paint is still sticky, and apt to impart a little of its coat to the clothes of any one who is unfortunate enough to come in contact with it.

Paint should be bought ready mixed.

1566. The oil and colour man mixes paint of any colour generally at 6d., and sometimes even at the low rate of 5d., per pound. He sends it to you ready for use in a tin can or an earthen paint-pot, and in addition to all this he will lend you a brush wherewith to apply it. This is useful where but little painting is done; but when the amateur frequently indulges in this kind of amusement, it is desirable that he should be possessed of his own brushes and other tools. The tools required by the amateur painter are very few, and those are mostly required for mixing the colours; the materials are the most important consideration, but these on the one hand are not expensive, and on the other may be easily obtained.

Price of paint supplied by oil and colour man.

1567. The great advantages of being able to mix one's own colours, which advantages may be set against those of procuring paint direct from the oil and colour man ready for use, may be stated as follows: colour can be mixed in a very little time, especially if the materials are at hand; any quantity may be made—just as much as is wanted and no more—whereas if paint be bought ready mixed, one is obliged to buy a certain quantity, when perhaps only a few brushfuls are wanted; and it can be mixed to dry either quickly or slowly, just as circumstances may render it desirable.

Advantages of mixing one's own colours.

1568. The only requisites for mixing colours are a slab of marble or piece of very thick glass, square, or of the shape shown in fig. 731; glass or marble being specified because the smoother the surface the more effectually the colour can be ground; a muller, also made of glass or marble, and of the shape shown in fig. 732; and a palette-knife, represented in fig. 733. This is a broad but thin and flexible steel blade, set in a wooden handle. It is useful for taking up colouring-matter to put on the slab, for scraping together the colour which the action of the muller has driven from the centre to the sides of the slab, and for transferring the colour when ground from the slab to the receptacle in which it is to be placed. This is generally an earthen pot

Requisites for mixing colours.

FIG. 731. MARBLE SLAB.

FIG. 732. MULLER.

Muller and palette-knife.

FIG. 733. PALETTE KNIFE.

of the shape shown in fig. 734, and as these are inexpensive, costing from 2d. to 3d. a piece, the amateur will find it convenient to keep six or eight. Palette-knives may be bought from 6d. to 2s., according to size; and for 2s. or 3s. a suitable piece of marble or glass for a slab may be procured and a muller made, completing the equipment of the amateur painter in this respect.

FIG. 734.
EARTHEN PAINT-POT.

Prices of palette-knives.

1569. The colouring-matter must be bought of the oil and colour man in the shape of powder; it is very cheap for the most part, although some pigments, as vermilion and ultramarine, are more costly; the amateur, however, will require only those most commonly used, which are the cheapest. When buying the colouring-matter he must also furnish himself with some *boiled* linseed oil, some turpentine, patent dryers, varnish, and gold size. The amateur must be very careful to get *boiled* oil, the other oil will not answer; indeed, the use of common oil is the cause in most instances of the failure of the paint to dry readily. The varnish required is either copal or mastic varnish.

Colouring-matter.

Boiled linseed oil.

1570. The price of colouring-matter for ordinary colours ranges from 3d. to 1s. per pound, but ultramarine is 3s. 6d. and vermilion 5s. per pound; boiled oil costs from 2s. 6d. to 3s. per gallon; the ordinary linseed oil costing 2s. 8d. per gallon; turpentine, or "turps," as it is generally called, costs 3s. per gallon; varnish, 1s. 6d. to 3s. per pint; gold size, 12s. per gallon; and patent dryers of the best quality, 3d. per pound.

Average prices of materials.

1571. To mix the paint the powder of the wished-for colour is laid upon the slab; if it is rather coarse it must be crushed, but if tolerably fine pour a little boiled oil on it, and with the muller give it a thorough good grinding. There need not be the slightest fear of powdering it too fine, because the finer the better. Sufficient oil should be used to bring it to a paste. The circular sweep of the muller will, as it has been said, have a tendency to spread the paint, and even to drive it off the slab; therefore when any portion of it is rather near the edge, the palette-knife should be used to bring it all in the centre of the slab, ready for another dose of grinding. The slab should be about 18in. square. It should stand in an out-of-the-way corner of the workshop, on a frame made to support it, and when not in use should be put out of sight under a wooden cover, like a shallow box or tray turned upside down, and supported on ledges

Description of process of mixing.

nailed to the frame, so that its inner surface may not come in contact with the top of the slab.

1572. If the paint is not required to dry so very quickly, or say in about twenty-four hours, then a little turpentine and about double the quantity of oil should be added. Paint mixed in this way will look nice and bright when dry, and have a good lustre.

Turpentine and oil.

1573. If it is of importance that the paint should dry quickly and still have a bright appearance, it should be mixed with turpentine and some gold size added when mixed. If it is wished to make a paint to dry in twenty minutes or half an hour, it must be mixed with turpentine and without oil. When dry this paint will have a very dead, lustreless appearance, and requires a coat of varnish afterwards to make it look as it ought. This is a method very often adapted for iron-work.

Gold size.

1574. The addition of a little patent dryer to either of the mixtures will make the paint dry quicker, but it cannot well be mixed with some colours because it deadens the tint. Gold size also causes paint to dry very quickly. The ordinary dryers most in use are sugar of lead, litharge, and white copperas. Red lead is also an excellent dryer, but this from its colour cannot be used with all paints. Sugar of lead is the most expensive, but it is also the best. It is better not to mix dryers with delicate colours, because the tints are often slightly injured by their introduction. A good drying oil is made by boiling half a gallon of linseed oil with two ounces of litharge. The oil should be allowed to boil slightly until no scum is thrown up to the surface; it must then be allowed to cool, and poured in a bottle for future use.

Patent dryer.

Various kinds of dryers.

1575. We may pass on now to the brushes used by the painter in house-painting. These are distinguished as "brushes" and "sash tools," the larger brushes being included under the former title, and the smaller ones under the latter. The origin of the name "sash tool" is obvious, as the small brush so called clearly derived its title from being employed in painting sashes, mouldings, and other small work; the larger brush being used to spread paint over broad, flat pieces of wood, such as the styles, rails, and panels of doors, over which it can be passed very rapidly.

Brushes used by painters.

1576. Types of the varieties of brushes used by house-painters are shown in the annexed illustration. In this, fig. 735 represents the large dusting brush, used for removing all dust from work prior to the application of paint. The hair of this brush is longer than that of the ordinary paint brush, which is shown in fig.

Dusting brush.

736, and which is made in three sizes, and either round or oval in form. The brushes are made of bristles set in a round or oval piece of wood, bound round with string or copper wire. In this piece of wood the conical handle of the brush is also fixed. The oval brushes are said to be preferable to the round brushes, because they require less working to get them into a suitable shape for spreading the colour smoothly and evenly. To hasten this desired end, painters will often use a round paint brush in the place of a dust brush, until by long use in this capacity it has been brought into decent working order. The sash tools, which are represented in fig. 737, are made in twelve sizes, numbering from 1 to 12, and are bound with string, as shown in the illustration, or encased with tin.

Ordinary paint brush.

FIG. 735. DUSTING BRUSH.

FIG. 736. ORDINARY PAINT BRUSH.

FIG. 737. SASH TOOL.

Sash tools.

1577. Different methods are of course used in painting new work and repairing old work, and it will be useful to the amateur to give a brief description of the process generally followed in each case from the commencement to the conclusion.

Process followed in painting.

1578. Before beginning to paint *new work*, all projections, such as lumps of glue, etc., must be cleared away with the putty-knife and duster. Then all the knots in the wood must be killed with *knotting*, to prevent the turpentine in the knots from oozing out and spoiling the appearance of the painting when finished. Knotting is a preparation of red lead, litharge, boiled oil, and a little turpentine; the amateur is advised to buy the "patent knotting," which may be had of the oil and colour man ready for use. After the knotting is applied, which dries and hardens very quickly, the *priming*, or first coat, is put on. This is made of white lead, with some dryers, and a little red lead to harden it. It is made very thin with oil, as unpainted wood or plaster absorbs the paint very quickly. Sometimes new wood has a coat of *clear-cole* applied to it, which is a mixture of size and a little whiting. The suction of the wood is stopped by the clear-cole, but the oil paint does

Cleaning wood, and applying knotting in new work.

Priming or first coat.

Clear-cole.

not adhere to the work as closely as it does when the wood is properly primed. Clear-cole, however, is useful on old and dirty wood which has never been painted, and on which, especially if greasy, oil paint would not dry.

1579. As soon as the priming is dry, all holes made by punching in the heads of nails, cracks, etc., must be stopped with putty. It is useless to attempt to do this before the priming has been applied, because putty will not stick to wood unless painted. After this has been done the *second coat* may be applied; and for new work the second coat of colour should be made up chiefly of oil, because oil is most efficient in stopping the suction of the wood; then a *third*, and even a *fourth coat*, may be applied. In laying on the colour, the brush should be passed backwards and forwards and in every direction, to spread the colour evenly and work it well into the wood, in the earlier coats. Finally, the brush should be drawn up and down, or backwards and forwards, as the case may be, in the direction of the grain of the wood, taking care to leave no marks of the hairs of the brush. In painting a door, or any piece of work in which part is sunk and part raised, the mouldings or any bead-work should be painted first with a sash tool, and then the panels, styles, and rails with a brush. No coat should be laid on a previous coat until that coat shall be perfectly dry and hard; and before beginning to paint any piece of work, whatever may be the number of the coat, every particle of dust that may have settled on it should be carefully removed with the dusting brush.

Application of second and following coats.

1580. Such is the method of procedure in painting new work. In painting old work the process is somewhat different; but in this, as in the case of new work, the successive steps of the operation must be described in detail from beginning to end.

Painting old work.

1581. When about to re-paint old work, all dirt and projecting pieces must be carefully removed, and if the paint appears greasy it should be washed with turpentine. Sometimes a good washing with weak tea water, made by pouring boiling water on tea leaves that have been already used for making tea, will prove effectual. Whenever pieces of paint have come away through sun blisters or other causes, the patches must be painted over with a coat of priming. All defects must then be stopped and made good with putty, when the new coat may be applied.

Old work must be well cleaned.

Preparations for new coat.

1582. The composition of the paint that is applied to old work, and indeed to wood generally, must depend upon the style or manner in

which the work is to be finished. The first coat after the priming in new work should be paint in which the oil predominates over the turpentine; but for the first coat for old work the turpentine should be in excess of the oil. Paint mixed with oil in excess will present a shining surface when dry, but paint mixed with turpentine in excess will present a flat, dead, dull appearance. Therefore, when a shining surface is required, it is necessary that the under coat should be paint mixed with turpentine, the final coat being mixed with oil; but when the finishing coat is to be "flatting," as it is technically called, it must be laid over an under coat or ground colour mixed with oil.

Composition of paint for old work.

1583. When the surface of a coat of paint, that is to say, of any under coat, appears rough, especially in the case of patches in old work that have been re-touched, the paint, when dry, should be rubbed down with fine glass paper until the roughness has disappeared. All loose paint, or paint that appears loose round the blister-marks, should be scraped away with a knife before the putty is put on. For cleaning old greasy smoke-stained paint, limewash or limewater may be used. This kills the smoke or grease, on which no oil paint will ever dry and harden. Some will put a coating of weak size over the smoke and grease; the paint will dry on this, but it is very likely that it will soon crack and peel off.

Roughness of surface.

Removal of loose paint.

1584. It is not desirable to keep loading on coat after coat of paint on old work. It is better, when the incrustation caused by successive coats of paint has become very thick, to remove the paint entirely and begin *de novo*. There are various modes of removing paint. The professional painter will do it by the agency of heat, applying a flame to the surface of the paint; the heat soon softens the colour, and it may then be scraped away with a knife.

Removal of paint from old work.

Paint softened by heat.

1585. Removal of paint by heat necessitates the employment of a special apparatus; the amateur, however, may save himself the expense of this by adopting one or other of the following modes. The first and second involve least trouble, and either will be found effectual.

Other modes of removing old paint.

Recipe.—*To Remove Old Paint from Wood-work.* (1) Make a very strong solution of common washing soda, and apply it to the paint with a brush until the paint can be scraped away. (2) Apply naphtha to the paint in the same manner, giving it a second and even third damping with this offensive spirit until the paint yields. When soft

enough, scrape it away with a knife. (3) Slake 3lbs. of stone lime in water, and then add to this 1lb. of American pearlash, and sufficient water to bring the whole to the consistency of thick cream. Apply the preparation with a brush, and leave it on the paint for from eighteen to twenty-four hours, when it will be found that the paint is softened and may be easily scraped off.

Apparatus for application of heat.

1586. If, however, the amateur desires to remove paint by heat, the best thing that he can have for effecting his object is the "French Patent Self-acting Blowing Apparatus," which is shown in fig. 738. This consists of a case resembling a lantern in some measure, and having a spirit lamp inside filled with a jet so contrived as to cast a broad, flat flame upon the surface of the paint. The heat of the flame acts on a large part of the surface wherever the lamp is held to the paint, and the paint is soon rendered soft enough to be scraped away with a knife.

Fig. 738.
Apparatus for removing paint.

Plaster requires more paint than wood.

1587. A greater number of coats of paint are required on plaster than on wood, because plaster will absorb more oil than wood will. Thus, if three coats of paint are sufficient for wood-work, four and sometimes five coats will be wanted for plaster. Less paint is of course required when the plaster has had time to dry and harden properly, and indeed no paint should be put on plaster before it is perfectly dry.

Process of painting plaster.

1588. In painting plaster, the first coat should consist of white lead well thinned with oil, and having a little litharge added to it to ensure its drying quickly. The second coat should be altogether similar in character. The plaster will now be saturated with oil to some depth below the surface, and to the third coat may be added some turpentine, and some of the colour with which the walls are to be tinted when finished. The fourth coat should consist of paint of a darker shade of colour than that to be used for the finishing coat, mixed with equal quantities of oil and turpentine. The last coat should be mixed with spirits of turpentine only, and a little gold size to harden it and promote quick dryth. This coat, which is called the "flatting" because it dries without gloss, should be somewhat lighter than the selected tint, because it will dry darker. In painting plaster, every successive coat should be allowed to dry thoroughly and remain for four or five days before the next is put on; the last coat but one, how-

Flatting, how managed.

ever, should not be allowed to stand more than two days before the finishing coat is laid over it.

1589. The amateur will find it necessary, perhaps, to do his painting work at intervals, often few and far between. If he leaves paint in the paint pot for some length of time, he will discover, much to his annoyance, on resuming work that the paint is too hard and thick to be used. The addition of some oil and turpentine may save a little of it, but it will neither work pleasantly, nor, indeed, be worth using. Whenever paint must be put aside, a little cold water must be poured on the top of the paint. This prevents the evaporation of the oil, and keeps the paint all right for future use by excluding the air and preventing its action in drying and hardening the paint.

How to keep paint moist in pot.

1590. Similarly, brushes not in use should have the bristles or hair kept under water, that they may remain soft and flexible. It is better, however, when the amateur painter does not know how long it may be before he uses his brush again, to wash the colour well out of it by means of a little turpentine, and then to allow the brush to dry. When kept in water for some time, the constant soaking will rot the string and the bottom of the wooden handle to which the bristles are attached, and the amateur, on commencing painting, will experience the annoyance of his brush snapping off short like the end of a carrot.

Brushes in use must be kept in water.

Washing out in turpentine.

1591. The composition of priming for new work has been described; the proportions of the ingredients used for second and following coats for old and new work, and the meaning of certain expressions used in painting to imply combinations of a certain number of coats, are given in Spon's "Workshop Receipts" as follows:—

Composition of paint for different coats.

(1) "*Second Colour for New Work*, or oil second colour.—White lead thinned with oil and a little turpentine, with some dryers. About 1½oz. of dryers to 10lbs. of white lead is the usual proportion, but in winter more must be used.

(2) "*Second Colour for Old Work*, or turpentine second colour.—White lead thinned with about three parts of turpentine to one of oil, with a little dryers. Where much turpentine is used less dryers are required.

(3) "*Turpentine Colour.*—Colour thinned almost entirely with turpentine, and used only when the work is to be finished in oil, so that the last coat may have a better gloss.

(4) "*Third or Ground Colour.*—Colour thinned with two parts oil and one part turpentine, and

tinted a shade darker than the finishing colour.

(5) "*Finishing Oil Colour.*—Thin with a little more oil than turpentine, and tint to the desired colour.

(6) "*Flatting*, or finishing turpentine colour, is thinned entirely with turpentine and has no shine.

(7) "*Bastard Flat* is thinned with turpentine and a little oil, which renders it more durable than the perfect flatting. To procure a good flat, it is necessary to have a perfectly even glossy ground, and it should be of the same tint, but a little darker than the finishing flat."

1592. The terms for certain combinations of coats given in painting, and the various kinds of coats that each term implies, are as follows :— **Terms for combinations of coats.**

(1) "*Clear-cole and Finish.*—Stop defects with putty, clear-cole, and finish with oil finishing colour as directed.

(2) "*Two Coats in Oil.*—Turpentine second colour, and finishing oil colour.

(3) "*Two Coats in Oil and Flat.*—Turpentine second colour, third colour, and flat.

(4) "*Three Coats in Oil.*—Turpentine second colour, turpentine colour, and finishing oil colour.

(5) "*Three Coats in Oil and Flat* (old work). — Turpentine second colour, turpentine colour, third or ground colour, and flatting.

(6) "*Four Coats in Oil* (new work).—Oil priming, oil second colour, turpentine colour, and oil finishing colour.

(7) "*Four Coats in Oil and Flat* (new work).—Oil priming, oil second colour, turpentine colour, third or ground colour and flatting."

1593. Before quitting this part of our subject it will be useful to the amateur painter to mention the various pigments or colouring substances used in painting to produce different simple colours, and to follow these with a list of colours that are produced by combinations of two or more of these colours. White lead, a substance highly prejudicial to the health, both of those who manufacture it and those who use it, is mixed with all colours to tone them down and produce different shades, hues, and tints. There are, however, other mineral whites capable of supplying the place of white lead, which have the advantage of being non-poisonous pigments, and chief among these is the new mineral white invented by Mr. Thomas Griffiths, F.C.S., of Liverpool, an oxy-sulphide of zinc, the covering power and whiteness of which surpass those of any other substance, and are only approached by white **Colouring substances.** **Charlton zinc white.**

lead and white zinc or oxide of zinc. This brilliant and harmless white is now being prepared at Charlton, in Kent, by precipitating a solution of zinc by means of sulphide of barium, drying, pressing, calcining, and grinding.

1594. It is much to be hoped that this new white colouring matter, when better known, will entirely supersede the dangerous pigments now in use. Many colours by no means harmful in themselves are rendered so by their admixture with white lead, or through arsenic entering into their composition. Not only the green wall papers, but even the hideous dull olive and dark sage green colours now so fashionable, and the light blues and darker browns so commonly found in bedroom papers because they are cheap, are largely charged with arsenic. There is no occasion to use any arsenical colouring-matter for staining wall papers, for chemical discovery of late years has brought to light several new mineral colours that are alike brilliant and innocuous. For example, we have now the beautiful chrome, manganese, and baryta greens, which really compete wonderfully with the bright but dangerous arsenical green now so common on wall papers.

White lead injurious to health.

Arsenical colouring-matter.

1595. To return, however, from this digression on the poisonous pigments that are used in painting to the colours of all description that are used in house-painting, it will be convenient to classify each set of colouring substances, whether mineral or otherwise, under the colour which it yields when properly mixed.

Classification of pigments.

1596. TABLE OF SIMPLE COLOURING SUBSTANCES.

(1) *Whites.* — White lead, including Ceruse and Flake White, Zinc White (oxide of zinc), Griffith's Zinc White (oxy-sulphide of zinc — non-poisonous), Nottingham White, Bougival White, Spanish White.

(2) *Blacks.*—Lamp Black, Ivory Black, Blue Black, Vegetable Black, Patent Black.

(3) *Yellows.*—Chrome Yellow, Turner's or Patent Yellow, Naples Yellow, King's Yellow, Orpiment, Massicot, Yellow Ochre, Raw Sienna, Yellow Lake.

(4) *Reds.*—Vermilion (crimson and scarlet), Carmine, Cochineal Lake, Madder Lake, Red Lead or Minium, Indian Red, Venetian Red, Spanish Brown, Purple Brown, Orange Lead, Burnt Sienna.

(5) *Browns.* — Umber (burnt and raw), Vandyke Brown, York Brown.

(6) *Blues.*—Prussian Blue, Cobalt, Ultramarine, French Ultramarine, Blue Verditer.

(7) *Greens.*—Verdigris, Scheele's Green, Emerald Green, Green Verditer, Italian Green, Saxon Green, Brunswick Green.

1597. TABLE OF COMPOUND COLOURS PRODUCED BY MIXING SIMPLE COLOURS.

Straw Colour.—Chrome yellow and white lead.

Lemon Colour.—Chrome yellow and white lead; more of the first than in straw colour.

Orange.—Chrome yellow and vermilion (bright), yellow ochre and red lead (duller).

Buff.—White lead and yellow ochre.

Cream Colour.—Same as for buff, but with more white.

Gold Colour.—Chrome yellow with a little vermilion and white lead; or Naples yellow and realgar.

Stone Colour.—White lead and yellow ochre, with a little burnt or raw umber.

Stone Colour (grey).—White lead, and a small quantity of black.

Drab.—White lead, burnt umber, and a little yellow ochre (warm); white lead, raw umber, and a little black (cool).

Flesh Colour.—Lake, white lead, and a little vermilion.

Fawn Colour.—Same as for flesh colour, with stone ochre instead of lake.

Peach Colour.—White lead, with vermilion, Indian red, or purple brown.

Sky Blue.—White lead, Prussian blue, and a little lake.

Olive.—Black, yellow, and a little blue; or yellow, pink, lamp black, and a little verdigris.

Chestnut.—Light red and black.

Salmon Colour.—Venetian red and white lead.

Chocolate.—Black, with Spanish brown, or Venetian red.

Sage Green.—Prussian blue, raw umber, and a little ochre, with a little white.

Olive Green.—Raw umber and Prussian blue.

Pea Green.—White lead and Brunswick green; or white lead, Prussian blue, and some chrome yellow.

Pearl Grey.—White lead, with a little black, and a little Prussian blue or indigo.

Silver Grey.—Same as for pearl grey.

Grey (common).—White lead and a little black.

Lead Colour.—White lead with black or indigo.

Violet.—Vermilion, white lead, and indigo or black.

Purple.—Violet as above, with the addition of a rich, dark red, or colours for French grey.

French Grey.—White lead with Prussian blue and a little lake.

Lilac.—Same as for French grey, but with less white.

Oak Colour.—White lead with yellow ochre and burnt umber.

Mahogany Colour.—A little black with purple brown or Venetian red.

1598. In addition to the above it may be said that *greens* of all imaginable shades and varieties may be produced by the admixture of

the various blues and yellows. But, as it has been said, the amateur who is not disposed to mix his own colours may procure any kind of green, and any or almost any of the colours above described ready mixed for use in handy little tin pots or cans, at the rate of 6d. per lb., which is no more than he would have to pay any oil and colour man for mixed colours. Excellent colours are manufactured and supplied at this rate by MESSRS. PONTIFEX AND WOOD, *Shoe Lane, London, E.C.*, in cans holding from 1lb. to 14lbs. One advantage of using colours purchased in this way is that the tin can serves as a paint pot until the paint is used up, when the can can be thrown away. Some makers send out cards with specimens of their colours attached to them, and if the amateur does much painting he will find one of these cards useful to him in helping him to discriminate between the various colours, and make his selection accordingly.

Paints ready mixed in cans.

Specimens of colours.

1599. Another excellent series of colours ready mixed, and sent out in hermetically sealed cans, are Pulford's Liquid Magnetic Paints, prepared and sold by the manufacturer, MR. G. C. PULFORD, 77, *Cannon Street, London, E.C.* These paints are used in every department of the Government at home and in India. They will keep in a soft state for years, and when applied to iron or wood will dry in a few hours. They are supplied, in any colour, in cans hermetically sealed, which form paint pots, in quantities of 7lbs., 14lbs., and 28lbs., at the rate of 6d. per pound. They are more economical than many ordinary paints, and are peculiarly well adapted for the purposes of the amateur.

Pulford's Liquid Magnetic Paints.

1600. Graining and marbling will scarcely be attempted by the amateur. Either kind of work when badly done is very unsatisfactory, not only to the painter himself, but to all who happen to set eyes on it; while to do graining and marbling well requires considerable taste and artistic skill in imitating woods, and many years of practice. There are certain painters who do special work of this kind for the trade, and *writing*, as it is called, or the painting of names, etc., over the facias of shops, or in any required position. These men earn high wages and do nothing else.

Graining and marbling.

1601. The painting of a common wood to imitate any more expensive wood, such as oak, mahogany, bird's-eye maple, etc., is called *graining*. To do this the colour for the ground, which is some light colour, generally yellow, is first laid on and allowed to dry. When thoroughly dry and hard, a coat of dark, rather slow drying paint is laid upon the light ground, and while this is wet

How graining is done.

the surface is diversified by drawing combs of leather or metal and graining brushes over it. These combs and brushes take off some of the dark-coloured paint, and expose the light ground colour. When properly done it has a very good effect, but the amateur, unless he has a natural talent for painting, will find that the chief difficulty in graining is to do it properly.

1602. Marbling—we are now speaking of the commonest kinds of marbling only—is not so difficult as graining, although to the imitation of verd-antique, jasper, malachite, sienna, porphyry, etc., the same remarks apply that have just been made on graining. Common kinds of marbling are those usually known as white marble and black and gold marble. For the first kind, the object to be marbled out must be painted white; for the second, it must be painted black. On the white surface, veins and streaks of black and grey must be put on with a camel-hair pencil; diversity may be given to these streaks and veins by the use of a feather, just as it is, or notched to produce various markings. On the black ground veins of white lead, yellow ochre, and burnt or raw sienna must be made by the same means. The spaces between the veins should be thinly glazed with grey or white, diversified with veins of a stronger and more decided white. Instead of a black ground a yellow ground is sometimes put on, which is diversified by broad, strong streaks of black. While the black is still wet, veins are drawn in it with a sharp-pointed stick, which removes the black and exposes the yellow ground below.

Marbling and how to do it.

Various kinds of marbles.

1603. The leather and metal-graining combs with which graining in imitation of any kind of wood is done, may be bought at comparatively low prices of any oil and colour man. The amateur, indeed, may make his own leather combs, as they are nothing more than pieces of tolerably stout leather, notched as shown in fig. 739. Of course different widths of teeth are required for different kinds of graining. Graining rollers are made for imitating various kinds of wood, but when these are used the effect produced is more monotonous than when the graining is done by hand.

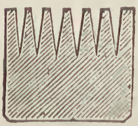


FIG. 739. LEATHER GRAINING COMB.

Leather and metal graining combs.

Graining rollers.

1604. Different coloured grounds are used for different kinds of wood. For example, for *dark oak* a ground of yellow ochre, venetian red, and white lead is used; for *dark wainscot oak*, chrome yellow, yellow ochre, and white lead; for *light wainscot oak*, yellow ochre and white lead only. The tints

Grounds for different kinds of wood.

to be laid over the ground are, for *dark oak*, vandyke brown and raw sienna, and for *light oak*, burnt umber, finely ground, and raw sienna, mixed with turpentine and linseed oil in equal parts, and a little patent dryers. This colour must be laid on evenly and smoothly, and the streaks and markings produced by wiping parts of this colour away with the combs already described, fine steel combs, cork combs, etc., presenting various gradations and widths of teeth. The light smudges intended to represent the medullary rays are made by wiping away the colour with a piece of rag or wash leather. It is impossible to teach the amateur painter how to do graining and marbling by a mere description of the process. He will best learn how both are done by watching a professional grainer at his work. When grained work and marbling are dry they must be varnished. Every description of article, such as combs, rollers, etc., used in graining, and graining colours for use with the rollers, ground in water, prepared thick and only requiring thinning before using, are kept by Messrs. Brodie and Middleton, 79, *Long Acre, London, W.C.*, who will readily supply the amateur with any information he may require with regard to colours and all kinds of tools used in painting.

Graining can only be learnt by watching the operation.

1605. Painting in distemper is done with colours prepared very much in the same way as whitewash, though not in so large quantities; indeed, whitewashing, as well as all painting done in colours prepared with size, is called *distempering*. The difference between painting in oils and distempering is just this, that in the former the colouring matter is ground with oil and turpentine, while in the latter it is mixed with size. Ceilings are usually painted in distemper because a lighter effect is produced than when oil colours are used.

Painting in distemper.

1606. Scene-painting is done in distemper, but in this the colours are laid on canvas, or some similar material, which is first primed with a wash of the same kind. Here, however, we have nothing to do with scene-painting, but have to speak of distemper as applied to house-painting. It may be applied to wood-work, but it is not likely that it will stand long, for whitewash, when put on wood, soon dries, chips, and peels off. Generally speaking, in house-painting distemper is applied to plaster only, and then the first thing to be done is to stop the suction or absorbing power of the plaster. Sometimes this is effected by giving the plaster a couple of coats of oil paint before the distemper is put on. This lends a richness to the colouring, but has the bad

Scene-painting.

Distemper as applied to house-painting.

effect of increasing condensation on the walls in cold damp weather, the surface of the walls being rendered colder by the oil paint. The water thus condensed will ultimately trickle down the wall in little streams, and stain and otherwise injure the distempering.

To stop absorption of plaster.

1607. Stopping the absorption of the plaster is said to be best effected by mixing about 10lbs. or 12lbs. of good whiting with water until it assumes the consistency of paste, and then adding to it enough size to bind it with about two ounces of alum, which hardens the distemper, and helps it to dry out solid and even, and two ounces of soft soap dissolved in water. These ingredients must be well mixed and strained through a coarse cloth, or a strainer of metal perforated with small holes. To ascertain whether enough size has been used, try the colour on paper and dry it before the fire. If there is not enough size in the composition it will be easily rubbed off, but if there is enough it will stand any amount of rubbing without injury, except such as soils and stains from dirty hands.

Laying on distemper colours.

1608. In laying on distemper colours, which should be done with a large flat brush in the same manner as whitewash, it is the better plan to close the doors and windows while the colour is being laid on, and to throw them wide open as soon as this is done. The exclusion of the air during the process of colouring prevents that which is laid on first from drying too quickly, which too often has the effect of showing the joinings of the large patches, so to speak, in which the colour is laid on. The admission of the air as soon as the colouring is completed causes rapid evaporation of the moisture, and renders the whole surface uniform in tint. Of course the colour must be laid on evenly and smoothly, and the same consistency must be preserved throughout.

Size of good quality necessary.

1609. Attention is necessary to the quality of the size that is used in mixing colours for distempering. Good size may be bought of any oil and colour man for 1d. per pound. The amateur, however, if he be so inclined, may make size for his own use by following the accompanying directions, to which it may be useful to add a few hints on the composition of colours most commonly used in colouring walls in distemper.

Recipe.—*To make Size.* Take a sufficient quantity of shreds and cuttings of parchment. Put them into a saucepan and let them soak in cold water for from 24 to 36 hours, until the pieces are completely penetrated by the water. Then simmer for 6 hours, removing the scum that rises to the top from time to time. Strain the liquor through

a coarse hair-sieve or cloth. This is sufficient if the size is to be used immediately, but if it is wanted to keep, add alum, dissolved in boiling water, in the proportion of 1½oz. or 2oz. to a gallon, boil the size again, strain, and keep when it has cooled and jellied in a cool place.

How to make good size.

1610. With regard to the composition of colours for distempering, a wash must first be made of whiting for colouring rooms, or whitewash for ordinary purposes, to which sufficient size must be added to bind it. The size must be melted and added when warm. Lastly, add sufficient colouring matter to bring the wash to the tint required, using, for *pink*, rose pink; for *salmon*, venetian red; for *lilac*, a little indigo and rose pink; for *light grey*, lamp black; for *French grey*, Prussian blue and lake; for *blue*, Prussian blue, indigo, or cobalt; for *green*, emerald green, or Prussian blue or indigo, and a little chrome yellow or yellow ochre; for *orange*, Dutch pink and orange lead, which is a very difficult colour to work in distemper on account of its weight; for *buff*, yellow ochre, to which a little venetian red must be added if a warm tint be wanted; for *drab*, burnt or raw umber.

Composition of distemper colours.

1611. Stencilling is a kind of ornamentation well suited for rooms coloured in distemper and for ceilings. The pattern is cut in a thin sheet of metal, pasteboard, or thick paper; the perforated plate, whatever may be the material of which it is made, is then laid against the wall, and a brush charged with colour is passed over the openings. The pattern is then removed quickly and carefully, and the design appears imprinted on the wall. Excellent stencil patterns for facias, panels, pilasters, corners, and every kind of work to which stencilling can be applied, may be procured at the rate of 1s. 6d. per dozen, assorted sizes, from MR. E. GALLOP, 3, *William Street, Grapes Hill, Norwich.*

Stencilling.

Stencil patterns: where to get them.

FIG. 740.

1612. The accompanying illustration—fig. 740—is an ornament in stencil-work designed by Mr. Gallop, and will serve to show the

nature of this kind of work. The pattern is cut out in small pieces, connecting links being left here and there to keep the plate or card together. The design given is suitable for the centre of a panel. The amateur in removing the plate must be careful to remove the card by a direct forward motion, lifting it from the wall and not sliding it off, lest he should spoil the sharpness and clearness of the outline. The ground colour in stencil-work—that is to say, the colour of the pattern—may be enriched with bold shading or in relief with a dark tint, or even outlined with a darker or lighter colour, or with gold paint, but this will be found tedious and troublesome. It will be understood that fig. 740 is considerably reduced from the original design.

Design for stencil-work.

1613. For all wood-work in the interior of a house, and for exterior work under some circumstances, *staining and varnishing* is infinitely preferable to painting, partly on account of the ease with which it is done, and partly on account of the durability of this mode of finishing wood-work, owing to the hard exterior which is imparted to it by the varnish. All re-painting is rendered unnecessary, and the work never requires to be stained again; all that is necessary is to clean the old coat of varnish and put on a new one when the surface appears to want freshening up. For cleaning all varnished work there is nothing better than weak tea-water, as it has been said. As stains for wood, there are none better than those manufactured and sold by MR. HENRY C. STEPHENS, 171, *Aldersgate Street, London, E.C.* By means of these preparations, wood may be effectively stained in imitation of oak, mahogany, rosewood, ebony, walnut, wainscot, and satinwood.

Staining and varnishing.

Stephens' stains for wood.

1614. The advantages resulting from the use of Stephens' Stains for Wood are numerous. They are *economical*, for the process is so simple that it may be carried out by any one without any instruction or experience whatever, while painting requires some amount of skill to do it properly, and involves considerable outlay in colour. They are *far more durable than paint*, for, as shown by experience, they show little alteration, even after an interval of twenty years. Lastly, they *dry quickly and without smell*, and hence the whole interior of a house, which it would take a month or six weeks to paint, can be finished in one week.

Advantages of these stains.

1615. The process consists of *three* distinct operations:—first, *staining*; second, *sizing*; and third, *varnishing*. The wood should be rendered as smooth and even as possible with the plane, and all knots covered, and nail-holes

Operations in process of staining wood.

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filled by mixing a little of the stain with plaster of Paris till it assumes the consistency of paste; sappy portions of the wood should be damped with water. The stain may then be laid on plentifully with a brush *along the grain of the wood.*

Application of the stain.

1616. When the wood is thoroughly dry, it must be *twice* sized, using each time a very strong *solution* of size. The size must be dissolved in hot water, in the proportion of 1lb. to a gallon of water. The amateur is cautioned against using size stronger than this, and he must remember not to work his brush up and down when charged with size, for this, when the size is too strong, often produces a lather on the wood. The best way to apply size is to use it warm, and work the brush in one direction only, namely, from top to bottom or from one side to the other, as may be necessary. If an interval of twenty-four hours be left after staining, before sizing, the colour is softer and richer. As the beauty of the result depends mainly upon the grain of the wood, well-seasoned wood of beautiful figure and variety in the grain should be selected for choice work. When the second coat of size is thoroughly dry, the work must be varnished. When the wood is to be French polished, it should only be sized once before applying the polish. Exterior work should be sized once and varnished twice; and for rough work, boiled oil may be used instead of varnish.

Sizing stained wood.

Second coat of size.

1617. The different stains can be mixed together to obtain a modification of their respective colours, and they may be diluted with water to produce light shades. One coat of the walnut stain upon the best pine produces an exact resemblance to the very best English walnut, and two coats to the deep-coloured foreign walnut, the pine grain showing under this stain the dark streaks characteristic of walnutwood. Where a great depth of tint is required, as in imitation of Spanish mahogany or old oak, two coats of those stains may be applied before sizing. The white woods, such as ash, beech, birds-eye maple, elm, and American birch, owing to the greater boldness and variety of their grain, present, when stained, a richer appearance than any of the coloured woods.

Modifications of staining fluids.

1618. The stains for ebony or black wood and wainscot are sold only in the liquid form, but those for oak, mahogany, rosewood, walnut, and satinwood may be had in the liquid form or in the form of powder, which must be dissolved in *hot* water. The powders are sold in packets at 1s., 2s., 4s., and 8s., respectively containing sufficient to make a pint, a quart, half

Stains for ebony, wainscot, etc.

a gallon, and a gallon of strong liquid stain. The liquid stains are sold at 8s. per gallon, and in bottles at 6d. and 1s. for the convenience of those who require a small quantity only. One gallon of stain will cover about 100 square yards. Size suitable to be used with the stains is sold at 1s. per lb., and varnish at 12s. per gallon.

Staining powders.

1619. In all operations of painting, staining, varnishing, etc., it is of the greatest importance that everything used, whether slab, muller, knife, or brushes, should be kept thoroughly clean. Directions have already been given for keeping paint and brushes from the hardening action of the air, by covering the former with, and immersing the latter in, cold water. This plan should be followed when but short intervals elapse between successive usings of the paint and brushes. When the painting is finished, and the brushes are to be laid aside for a time, if cleaned immediately after using, and while the paint is still moist, very little difficulty will be experienced in cleaning them; but if left until paint or varnish is dry and hard, it will be both a troublesome and an unpleasant job to get them to a proper state. Brushes should never be allowed to harden. If paint brushes cannot be cleaned just after use, they should be kept in oil until it is convenient to clean them properly. If cleaned whilst moist a little soap and water will make them as good as new. They are generally kept with the hair imbedded in a lump of grease, that prevents them from getting hard and stiff.

Appliances used in painting must be kept clean.

1620. Varnishes may be bought of the oil and colour man at the following rates:—Copal varnish at from 12s. per gallon upwards; white hard spirit varnish at from 8s. per gallon upwards, and smaller quantities in proportion. Those, however, who may wish to make their own varnishes will find the following recipes to be among the best.

Varnishes, and recipes for making varnishes.

(1) *Gold varnish.*—Thoroughly wash and cleanse from colour one part of gum lac; when dry pulverise it well, reducing it in a mortar to an impalpable powder; mix with it four times its weight of spirits of wine; put the mixture on the fire, and let it remain until the gum is entirely dissolved. Strain the liquor, and keep for use in a well-corked bottle.

Gold varnish.

(2) *Copal varnish for fine painting.*—Fuse four pounds of the palest African gum copal; when completely fused, pour in one gallon of hot oil; boil it till it strings strongly, which may be known by dipping anything in the mixture, and observing the threads that run from it. In ten minutes or so, before the

Copal varnish.

mixture gets cold, add 1½ gallons of turpentine. Strain it through a cloth, and then if too thick add, whilst the mixture is hot, enough hot turpentine to bring it to the required consistency.

Best white hard spirit varnish.

(3) *Best white hard spirit varnish.*—Add to a quart of spirits of wine ½lb of the best gum sandarac; agitate till complete solution of the gum is effected. Gently warm and render quite fluid 4½oz. of Venice turpentine; this must be added to the preceding mixture to give it body. Agitate until the ingredients are thoroughly mixed and amalgamated. Bottle the varnish and keep it from the air; after standing quiet for a few weeks it will be fit for use.

Black varnish for metal.

(4) *Black varnish for metal, etc.*—Fuse and thoroughly incorporate asphaltum, ¾lb.; shell lac, 2oz.; turpentine, 1 quart. Lay on with a brush.

Paint-work improved by varnishing.

1621. A few coats of varnish much improve painted or stained work by imparting a smooth and glossy surface to them. For some work, such as staining, one or two coats will be sufficient, but where it is desirable that the appearance of the article should be as good as it can possibly be got, eight or ten coats will have to be laid on. After the first three or four coats are given and thoroughly dry, take some fine glass-paper and smooth off the brush marks or any gritty particles that may have stuck to the varnish. Then give the work another coat of varnish, which serve in the same manner, and so on for every coat until the last, which should be polished with a flannel rubber dipped in Tripoli powder and water, and finished off with a powder made of suet and flour.

Brushes should be well washed after using them.

1622. The same precautions must be observed with regard to the brushes used in varnishing as for painting. If put away wet with varnish, after remaining unused for a day or two they will be hard and utterly useless; they must therefore be well washed immediately after use, and will then be in proper order when again wanted.

Polishing and recipes for polish.

1623. Polishing very greatly improves the appearance of articles made of any fancy wood or stained work. There are many different sorts of polish; but those for which recipes are given below will be found to answer the amateur's purpose in every way.

French polish.

(1) *French polish.*—Spirits of wine, 1 pint; gum sandarac, ¼oz.; gum lac, ½oz.; gum shell lac, ½oz. Expose the whole to a gentle heat, frequently shaking the mixture until the gums are dissolved.

(2) *Naphtha polish.*—Wood naphtha, ¼ pint; orange shell lac, 1oz.; dragons' blood, ¼ oz.; benzoin, ¼ oz. Prepare in the same way as French polish.

Naphtha polish.

(3) *Shell lac polish.*—Orange shell lac, 1½ oz.; spirits of wine, 1 pint.

Shell lac polish.

1624. The method of applying these polishes is the same for all. A flannel rubber is made and dipped in the polish, and a piece of fine and old linen is then put over the rubber. When the polish oozes through the covering dip the pad into or slightly moisten it with linseed oil. Another way is to strain the linen over the flannel pad, and then to moisten the linen with a drop or two of the polish, and a drop or two of oil. The pad should be held in the right hand, and the linen strained tightly, so that the pad may present a rounded surface. Apply the pad to the surface of the wood in a series of light strokes made by a circular sweep of the hand until the surface is nearly dry, when the pad should be passed up and down in the direction of the grain of the wood. When the rubber is dry some more polish and oil must be put upon it in the same manner as before and the rubbing continued.

How to apply polish.

1625. Plenty of what is generally called "elbow-grease" should be given to the work, and not too much polish. Beginners generally lay on a large quantity of polish in clots or thick coats, but when this is done the polish does not look well, neither has it a permanent effect.

Elbow-grease necessary.

1626. No more polish should be laid on than is absolutely necessary: the polish should be well rubbed in and finished off with a little pure naphtha or spirits of wine, whichever happens to be the spirit that is used in the polish. The naphtha or spirits of wine, as the case may be, should *at first* be laid on very gently and with great care, otherwise it will dissolve and remove the polish already laid on; but if proper care is taken its effect will be not only to give the polish a better gloss, but to render it more lasting. Some woods absorb a great deal of polish. In order to prevent this absorption, a coat of gold size, or something of a like nature, is given before the application of the polish. When polishing mahogany or other ornamental or coloured wood, should there be any inequalities or faults in any conspicuous part of the object, fill them up with stopping, consisting of plaster of Paris mixed to the consistency of cream with water, tinted with staining or colouring matter corresponding with the colour of the article that is to be polished.

Finishing-off polish.

Caution in use of naphtha, etc.

Polishing mahogany, etc.

Mixture for stopping holes.

A mixture of putty, consisting of finely-pounded whiting and painters' drying oil and some colouring matter, will do quite as well. For large holes a composition of beeswax, resin, and shell lac is found very useful.

1627. Gilding may be described as the art of covering any substance or a portion of it, such as wood, plaster, leather, and paper, by fastening thin *leaves* of gold to them by the aid of some cementitious matter, generally known as mordant or gilders' size. It will be necessary here to describe briefly the materials used in gilding—that is to say, the gold leaf and gilders' size; the tools by means of which the leaf is applied to the surface to be gilded; and thirdly, the processes known as oil gilding and water gilding. Nothing will be said here about the gilding of metals, as these are gilt either by amalgamation or by the action of galvanism. It is not likely that the amateur will ever attempt to gild metals by these means, as the first method is injurious to health, and the second requires special apparatus which he might scarcely care to purchase.

Gilding, how described.

1628. Good gold leaf consists of gold beaten out by the gold-beater to extreme thinness. It is said that an ounce of gold may be beaten into 1600 leaves, each three inches square, and about the 282,000th part of an inch in thickness. Even the best gold is mixed with alloy of silver or copper to the extent of from three to twelve grains in an ounce, because pure gold is too ductile to be worked between the vellum sheets or gold-beater's skin in which it is necessary to confine it during the process of beating. When beaten out thin enough for use the gold is placed between the leaves of small books about 3¼ in. square, red bole being rubbed over the leaves to prevent the gold from sticking to the paper. Each book contains twenty-five leaves, and is sold for 1s. 3d. or 1s. 4d. Inferior descriptions of gold leaf are made, which are sold at about half the price of the best, and "Dutch metal" is sometimes used as a substitute for gold leaf in cheap and common work. Dutch metal is copper coloured yellow by exposure to the fumes of zinc. It costs about 2d. per book.

Gold leaf, its preparation.

Sold in books.

1629. The principal mordants, or sizes, used by the gilder are known as *gold size* and *fat-oil gold size*. The former is composed of 1 part of yellow ochre, 2 of copal varnish, 3 of linseed oil, 4 of turpentine, and 5 of boiled oil thoroughly incorporated. Before the yellow ochre is mixed with the other ingredients it must be reduced to the form of very fine powder, and ground up with a little of the linseed oil. Fat-oil gold size is made by grinding stone ochre

Mordants, or sizes.

reduced to a very fine powder with old fat linseed oil. This should be made and kept for some years before it is used. As it is ground up very stiffly so as to present the appearance of stiff paste, it must be mixed with a little fat boiled oil before it is used.

Tools required in gilding.

1630. The tools required in gilding are a cushion, a knife, a tip, some camel-hair brushes, and some cotton-wool. The cushion is a piece of wood about 8in. long and 5in. wide, having loops underneath, through one of which the thumb is thrust in order to hold it, while the others serve to hold the knife and camel-hair brush. The top of the wood is padded with three or four thicknesses of baize or woollen cloth, over which a piece of wash-leather is tightly stretched. Along the back and one of the sides is a parchment ledge 3in. high, which prevents the gold leaf from being swept off the cushion by any chance current or puff of air. The knife is a long, thin, flexible blade, set in a wooden handle like a palette-knife, and is used for cutting the gold leaf into pieces as may be required after it has been placed on the cushion. The tip is a broad, flat brush of squirrels' hair inserted between two pieces of card, and is used for taking up the gold leaf from the cushion, and placing it on the size. The camel-hair brush and cotton-wool are used for pressing the leaf into hollows and depressions, and for brushing away superfluous pieces.

The cushion: how to make it.

Knife and its use.

Oil gilding and water gilding: why so distinguished.

1631. Oil gilding and water gilding are thus distinguished because, when the former method is resorted to, the object to be gilded is sized with glue size, and covered with two coats of oil paint and one of flatting, generally of a red or yellow colour. In water gilding, on the contrary, the wood is covered with several coats of whiting and size, until a perfectly smooth and substantial coating is produced. Oil gilding will bear washing with water, and is always of the natural colour of the gold, generally spoken of as "dead" or "neat" gold. Water gilding will not bear washing or wetting in any way; but may be burnished to brightness with a burnishing tool of agate. Oil gilding cannot be burnished.

Procedure in oil gilding.

1632. In *oil gilding*, the surface of the material to be gilt must be rubbed smooth, painted, and flatted. Some size must then be strained through muslin, and a little put on the palette and coloured with a small quantity of yellow ochre or vermilion ground with it. The surface, or such parts of the surface as are to be gilded, must then be coated with size, applied with a stiff

brush of hogs' hair. The size must be laid on smoothly, and in sufficient quantity, but not too thick. When the size has hardened sufficiently, so as not to come off when touched, but merely to feel sticky, the gold leaf may be applied. Size takes from 12 to 36 hours to get sufficiently hard for gilding; it dries more quickly in hot weather and more slowly when the weather is damp. To gild the surface some leaves of gold must be shaken out of the book on the cushion, and each in turn must be laid out and flattened, and cut in pieces if necessary with the knife. The tip must then be passed over the hair of the head, to render it slightly greasy, and applied to the gold, which will stick to it, and is thus removed from the cushion and laid on the size. When the surface, or such parts of it as are to be gilded, are covered with the gold leaf, it must be firmly pressed into its place with cotton-wool or the camel-hair brush, or flattened down with a hogs'-hair brush, applied as in stippling—that is to say, by dabbing the points of the bristles on the gold. Nothing now remains to be done but rub the gold over lightly with a piece of clean wash-leather.

Japanners' gold size. When japanners' gold size is used instead of oil size, the gold leaf may be applied about half an hour after the size has been laid on, or in about three or four hours if a mixture of one-third oil size and two-thirds japanners' gold size has been used.

1633. In *water gilding*, the surface given to the wood by successive coats of size and whiting is covered with gold size made of

Process of water gilding. American bole, a little white wax, and some good parchment size. The size must then be allowed to dry, and and when it has attained this condition, clean water must be applied to it with a soft brush, and the gold laid on the wetted surface. The leaf will adhere immediately to the size. When laid on it has the dead appearance always shown by oil gilding, but, as it has been said, any portion of the gold or the whole of it may be burnished to brightness by rubbing it with a piece of agate. Frames gilt in this way cannot be regilt by this mode of gilding without removing the coatings of size and whiting, and going over the whole process again from the very beginning. It must be remembered that water gilding will not bear washing, and must be protected in summer time from fly stains, etc.

1634. The gilding of small articles has been greatly facilitated by

Judson's gold paint. the production of what is termed "gold paint." That which is prepared by MESSRS. DANIEL JUDSON AND SON, 77, *Southwark Street, London, S.E.*, the manufacturers of Judson's Dyes,

which are now so well known and extensively used for decorative purposes of all kinds, is both cheap and serviceable. This paint, which is supplied in two bottles, one containing the gilding, and the other the vehicle by which it is applied, is sold with mixing bowl and brush complete for 1s. 6d. and 3s. 6d., the larger size containing as much as *four* of the 1s. 6d. sets.

Purposes to which it may be applied.

1635. The purposes to which Judson's Gold Paint may be applied are well-nigh innumerable. It may be used for re-gilding the frames of pictures and pier glasses, nothing more being necessary than to paint over the old gilding. Lamp-stands and gas-fittings may be gilt, and ormolu ornaments renewed with it. It is equally serviceable for illuminating and heraldic painting, and for gilding silk, leather, feathers, basket-work, shells, eggs, oak-apples, straw, etc., etc. A pleasing contrast is obtained by using it in juxtaposition with Judson's Artists' Black or Ebony Enamel, sold with a brush for laying it on at 1s. per bottle. The ebony enamel may be applied to wood and metal, and is useful for renewing any ebonised articles, as desks, small pieces of furniture, etc., door-plates, knobs, locks, etc. Decorative work done in the ebony enamel and gold paint on doors, cornices, brackets, etc., is highly effective.

Artists' black or ebony enamel.

CHAPTER XI.

PAPER-HANGING, AND HOW TO DO IT. GLAZING, OR WORKING WITH GLASS.

Paper-hanging—Saving in doing the work oneself—Plant required—What Wall-paper is—French Paper-hangings—How distinguished from English—How to Measure for Wall-paper—Illustration of Mode of Measurement—Allowance for Waste—Less Waste with Small Patterns—Allowance when Papering—Extra Pieces for Repairs—Paper made in Lengths—Ground of Cheap Papers—Prices of Serviceable Papers—Small Patterns most satisfactory—Papers for Staircases—Papers for Sitting-rooms—Flock Papers—Flock Papers Heavy in Appearance—Papers for Bedrooms—Papers for Sitting-rooms—Charges for Paper-hanging—Preparation of Wall to receive Paper—Stripping Old Paper—Re-papering Room after Infectious Disorder—Lime-washing necessary—Treatment of Damp Walls—Varnish of Naphtha and Shell Lac—Battening Walls—Match-boarding—Size, how to Prepare it—Tools required in Paper-hanging—Boards and Trestles—Good Paste for Paper-hanging—Method of Hanging Paper—Why a Wall should be Sized—Preparation of Whitewashed Wall—Loose bits of Plastering—Cracks to be filled up—Papering over old Paper—Treatment of Damp Spots—Where to begin to Hang Paper—Another Method—Finding the Perpendicular—Procedure after Determining Commencement—Preparation of the Paper—Cutting Edges of Paper—Cutting Paper into Lengths—Matching the Paper—How to Dispose Paper for Pasting—Pasting and Hanging Paper—Letting Paper fall into place—Pressing Paper against Wall—Trimming Edges above and below—Manipulation of Second Strip—How to Rectify Mistakes—Why Borders came into use—Patterns of Borders—Gilt Moulding as Finish—Where to Buy Gilt Mouldings—Panel Papering—Imitation of Dado, etc.—Panelling, etc., must be marked accurately—Effective Decoration for Large Room—Effect of Pictures in Panels—How to Clean Wall-papers—Varnishing Papers—How to Clean Varnished Work—Glazing—The Glazing that Amateur will do—Subjects Requiring Attention—Kinds of Glass used in Glazing—Crown Glass—Sheet Glass—Belgian Sheet Glass—Patent Rolled Rough Glass—Useful for Roofs of Greenhouses—Prices of Glass—Glass for Horticultural Buildings—Prices of Glass from Glass Cutters, etc.—Prices of Glass for Horticultural Buildings—Sizes in which Glass is supplied—Ready-made Lights—Sizes and Qualities of Ready-made Lights—Buildings must be made to Size of Lights—Some Lights must be Movable—Glazier's Diamond: how to use it—Hints and Appliances for Cutting Glass—The Graduated Board—The Glazier's Diamond—Where to Buy it Second-hand—American Glass-cutter—How to use it—Notches in Glass-cutter—The Putty Knife—Knife for Hacking Out—Repairing Broken Pane of Glass—Clearing the Rebate—Measuring Size of Glass required—Where Measurement should be taken—Allowance in Measurement—Best Mode of Measuring—Bedding of Putty for Glass—Puttying in Glass and Finishing—Putty: its Cost—Putty should be Bought Ready-made—Coloured Putty—How to Make Putty—Soft Putty—To Keep Putty from Cracking—To Soften Putty—Softening Putty by Heat—Treatment of Wood-work before Glazing—Proper Inclination to Glass—How to Secure it—Disposition of Putty—Extent of Overlap—To clean Glass—Darkening

Glass—How to Imitate Frosting—Summer Cloud—Memoranda on Glazing—Mode of Cutting Circular Panes—How to make Edges of Glass Straight and Smooth—Drilling Holes through Glass—Cutting Tubular Glass—Bickley's Patent Horizontal Sash-Bars—Structure and Use of Bar—Construction of Glass Roof with Patent Bars—Sizes and Prices of Bars—Advantages Derived from Use of Bars—A few words on what has been written.

1636. NEXT to painting, the most important decorative work that can be done within the house is paper-hanging, and a knowledge of the mode of doing this will often prove of great advantage to the amateur artisan, especially if he be a man of slender means. The saving will of course be in the cost of labour, the charge for hanging paper being 7d. per piece generally speaking, although there are many paper-hangers who will do the work for ½d. or 1d. per piece less. Against this must be set the length of time that the amateur will take to do the work; for, being unpractised, however skilful he may be in any kind of work that he may turn his hand to, he will take twice or three times as long in covering the walls of the room that is to be papered as the man to whom paper-hanging is every-day work.

Paper-hanging.

Saving in doing the work oneself.

1637. In describing the plant required and the method to be followed in paper-hanging, there are certain points to be considered which may be set down as follows: firstly, the wall or ground-work on which the paper is to be hung, and the modes of preparing it to receive the paper; secondly, the tools that are necessary; thirdly, the method of hanging paper; fourthly, various modes of treatment by which the appearance of paper-hangings may be improved; and, fifthly, how soiled wall-papers may be cleaned, or at all events freshened in appearance.

Plant Required.

1638. But before entering on these points, let us see what wall-paper is and how it is printed, or, technically speaking, "stained," the different descriptions of wall-papers, the use of borders, and the general prices of papers for decorative purposes, which vary according to material, design, and colour.

What wall-paper is.

1639. There are two kinds of wall-paper used in paper-hanging, one being of English and the other of French manufacture. The French paper-hangings are perhaps prettier, more artistic, and produce a better effect than English-made papers, but they are much more expensive. They may be distinguished from English papers by their narrow width, the English papers being 21in. wide and the French papers only 18in. Again, a "piece" of English paper is 12 yards long, and a

French paper-hangings.

How distinguished from English.

piece of French paper about 9½ yards, the former covering 7 square yards, or 63ft. superficial, and the latter 4¾ square yards, or 41 square feet. Speaking approximately, therefore, where two pieces of English paper are required, three of French will be wanted at the very least, and in practice this will not be found to be enough.

How to measure for wall-paper.

1640. On looking at a piece of wall-paper it will be found that the pattern does not come quite out to the edges, so that it must be remembered in measuring a room for paper, that 21in. in English papers and 18in. in French papers is the absolute net width of the pattern; the actual roll of paper itself is wider than this. To measure a room, cut a short rod or stick 21in. in length, and pass it over the four walls of the room, beginning in one corner and ending in the same, *omitting to measure the width of the window and the door with the rest of the room.* This is a simple and useful method for ascertaining the quantity required approximately, for the part that is allowed for the fireplace by this mode of measurement will, generally speaking, be enough to cover the space above the door, and above and below the window, and occasionally there will be dwarf cupboards in recesses, making spaces where no paper will be required. If, however, the room be very lofty it may be as well to omit only the door or window in the first approximate measurement. It will be understood that if French paper is to be used the rod with which the circumference of the room is to be measured must be only 18in.

Illustration of mode of measurement.

1641. To illustrate this mode of measurement, supposing that the room is 18ft. by 15ft., the whole circumference of the walls will be 66ft., which, supposing the door and two windows to measure, the one 3ft. 6in., and the others 3ft. 9in. each, will have to be reduced by 11ft., showing an extreme length of 55ft. to be covered with paper. The admeasurement with the 21in. rod will show that thirty-two breadths of paper are required—that is to say, thirty-two strips of paper 21in. wide. On the length of the strips, then, will depend the quantity of paper required. Let us suppose that the height of the wall between the skirting-board and cornice is 9ft.; then as the "piece" of paper is 36ft. long, it will cover four breadths; and as thirty-two breadths have to be covered, eight pieces of paper will be required. Had the height of the wall between skirting and cornice been 10ft., then a piece of paper, approximately speaking, would only cover three and a half breadths, and a little more than nine pieces would be required, and so on. Another method is to measure the circumference of the room, making allowance for doors

and windows, and having ascertained the number of feet, multiply this by the height of the room and divide by the number of square feet in a piece of paper. Thus, taking the room as before to be 18ft. by 15ft., and allowing 11ft. for doors and windows, and taking the height of the room to be 9ft., between skirting-board and cornice we have :

$\overline{18\text{ft.} + 18\text{ft.} + 15\text{ft.} + 15\text{ft.}}$ (length of 4 sides of room) — 11ft. (allowance for door and windows) $\times$ 9ft. (height between ceiling and skirting) $\div$ 63 (no. of square feet in piece of paper).

Or $\overline{66 - 11} \times 9 \div 63$, or $55 \times 9 \div 63 = 8$ pieces, or a trifle more, as before.

Allowance for waste.

1642. But in wall-papers, like all other kinds of material, there must be waste, and the waste will depend partly on the height of the room and partly on the length of the pattern, which is shown on one if not on both sides of the piece by printed marks that will be readily recognised by the amateur, now that their existence and meaning is pointed out to him. The smaller the pattern the less will be the waste, because the recurrence of the pattern is more frequent ; and conversely, the larger the pattern the greater the waste ; but then, again, it may happen even with a large pattern that the height of the room is such that the paper will cut in such a manner that the waste will be proportionately small. But be this as it may, it is always customary to allow one piece in seven for waste ; therefore, if by rough measurement it be found that it will take eight pieces of paper to cover the walls of a room, it will be necessary to buy eleven pieces, which will allow one and a few yards of another for waste and the remainder for repairs. The amateur should always bear in mind, when buying papers, to have at least a piece or two by him for repairs, for this will often save the necessity of re-papering the room when the paper has been damaged here and there by pencil marks, streaks from coming in contact with chair backs and other causes.

Less waste with small patterns.

Allowance when papering.

Extra pieces for repairs.

1643. Paper used for covering walls is made in lengths of 12 yards as described, and the patterns are imprinted on the paper by means of blocks, generally speaking, although some papers in imitation of woods and marbles are painted by hand. In cheap, common, low-priced papers, the ground of the paper, which is either white, pale brown, yellow, or grey, forms one of the colours of the paper, and on this one two or more colours are imprinted by blocks, so as to form a pattern. In cheap papers seldom more than two colours are used, and these are generally blues, purples, greys, and drabs. A cheap and showy-looking paper

Paper made in lengths.

Ground of cheap papers.

is made, apparently, by printing in purple or crimson madder on a brown ground, in imitation of flock paper, which costs 8d. per piece. Some cheap papers are sold as low as 2d. per piece, but these are not recommended if the amateur himself is going to do the paper-hanging, for they are so rotten and flimsy when damped with the paste that they will scarcely bear handling. Papers ranging in price from 6d. to 1s. per piece are good enough for bedrooms, and even for nurseries and breakfast-rooms, provided only that good patterns can be obtained.

Prices of serviceable papers.

1644. The most satisfactory kind of pattern is a small geometrical one, consisting of some simple form, a leaf or flower, conventionally treated. For staircases, passages, etc., papers in imitation of wood or marble are most commonly used, and these can be preserved from much casual injury by varnishing. Marble papers are usually hung in large blocks, the lines of demarcation, horizontal and vertical, being traced, by the aid of a straight-edge, in black or brown. For sitting-rooms satin papers, or papers with a glossy surface, are generally used, and the prices of these vary for the most part, according to the number of colours used in them, from about 2s. per piece upwards. Papers in which gold is introduced are expensive if they are worth anything at all. In cheap gilt papers, the gold, which is most likely Dutch metal, soon tarnishes and changes as time goes on from a dull copper-red to black.

Small patterns most satisfactory.

Papers for staircases.

Papers for sitting-rooms.

1645. Flock papers are made by smearing the surface of the paper in parts with some glutinous substance called flock gold size, made of linseed oil, litharge, Burgundy pitch, and other ingredients, and then powdering the parts thus smeared with flock. The flock consists of fine particles of wool formed by reducing pieces of old cloth to a state of powder, or very nearly so. Flock papers are heavy in appearance and expensive. Although green is so desirable a colour in wall-papers, on account of its coolness and agreeable effect on the eyes, it is better to avoid choosing any paper that has green in it, because arsenic enters so largely into the composition of nine out of every ten greens that are used in paper-staining. No attempt is made to give a schedule of prices for papers beyond what has been stated above, because the prices vary so much, according to the quality of the paper and the colour used, as it has been said. Generally speaking, the prices charged by the paper-hanger are under those charged by the builder. The prices for papers for lining, such as is used for cup-

Flock papers.

Flock papers heavy in appearance.

boards, etc., varies from 6d. to 1s. per piece. Pitch-paper, or india-rubber paper, as it is sometimes called, for damp walls, ranges from 9d. to 2s. 6d. per piece; tinfoil paper, used for the same purpose, is more expensive.

1646. Bedroom papers may be obtained as low as 2d. per piece, but the cheapest that can be fairly used range in price from 6d. to 1s. 6d. Papers done by hand range from 2s. 6d. to 5s. per piece; but printed granite, marbles, and wainscots, vary from 6d. to 2s. 6d., the low-priced papers being very poor in appearance, showy perhaps, but utterly inartistic. Papers for sitting-rooms may be procured at all prices, from 1s. per yard upwards; satins of the best quality ranging from 3s. to 6s., and flocks being even more expensive. Of course the addition of gold to a really good wall-paper increases the cost. The charge for hanging paper, which commences, as it has been said, at 6½d. or 7d. per foot, is generally increased when the paper is of good quality, because more care is requisite on the paper-hanger's part, and consequently more time is consumed in hanging the paper.

Papers for bedrooms.

Papers for sitting-rooms.

Charges for paper-hanging.

1647. From the material with which walls are covered, let us pass on to the wall itself, or the ground on which the paper is to be hung. If the wall be new it will require sizing before the paper is put up, though this is by no means done as a rule. If the wall has to be re-papered, it must be stripped of the old paper, or *should be* stripped, as new papers are but too frequently hung upon old papers; a procedure which is certainly not cleanly, and in many cases prejudicial to health, because the dampness caused by putting up the new paper often detaches the old paper from the surface of the wall, and oftentimes, if the paste used in hanging the old paper has been bad, a fungus is generated, which spreads over the wall in dark patches of a brown or greenish colour.

Preparation of wall to receive paper.

Stripping old paper.

1648. In re-papering a room after any one stricken down with some infectious disorder, such as scarlet or typhus fever, on no account should the old paper be left on the walls, but it should be carefully stripped and the walls washed, and the ceiling coated with limewash, after the old coating has been taken off with clean water. As soon as this is done, the walls may be sized and the process of re-papering may be proceeded with.

Re-papering room after infectious disorder.

Lime-washing necessary.

1649. Sometimes, however, it may so happen that the surface of a

wall is somewhat too damp for papering, or that it has not been plastered, or having been plastered shows spots and patches of damp here and there, which would soon take the colouring out of any paper that was pasted over it, and inevitably destroy the paper itself in due course of time. When this is the case, the surface of the wall must be either dressed with some preparation that will present a surface impervious to damp, or covered with an inner skin of canvas, so to speak, on which canvas may be stretched, and between which and the surface of the wall a current of air may be constantly circulating, drying the wall and preventing the canvas itself from contracting damp and showing those signs that bear unmistakable witness to its presence.

Treatment of damp walls.

1650. First with reference to curing damp in walls, various preparations for use inside and out have been already given in these pages. For internal use on plaster there is nothing better than a varnish made by infusing shell lac in naphtha. The smell is detestable, it is true, but the result is all that can be desired. The liquid, when applied with a brush, soon hardens into a dark red solid coating, utterly impervious to water, and on which paper may be hung without fear of injury. For internal walls wherever damp is perceptible, this preparation, which was first mentioned to the writer by a London painter and decorator of considerable experience, and which the writer has frequently used with the best possible effect, is recommended with confidence.

Varnish of naphtha and shell lac.

1651. If it happens, however, that the damp parts of the wall cannot be well healed in this manner, the wall must be battened; that is to say, battens, or pieces of wood 2in. wide and 1in. thick, must be nailed to the wall at intervals of about 18in., and over these battens canvas must be stretched. To get a surface as uniform as possible, the strips of canvas should be sewn together selvedge to selvedge. Whenever the canvas crosses a batten it should be nailed down to it with *tin* tacks or zinc nails, flat-headed and as short as possible, and the joinings of the canvas should have strips of brown paper pasted over them to hide the stitches in the seams. Sometimes this mode of forming a ground-work on which to hang paper is resorted to where walls have been covered with match-boarding, and the match-boarding being imperfectly seasoned has shrunk, exhibiting fissures between the edges. If paper were pasted over these narrow openings it would shrink in drying, and ultimately crack, rendering the appearance of the paper extremely unsightly. The canvas should be damped before it is stretched on

Battening walls.

Match-boarding.

the battens ; it will soon dry, presenting a surface as tight and well strained as the vellum head of a drum.

1652. When the ground-work, whether wall or canvas, on which the paper is to be hung is ready, the space to be covered with paper may be sized, though not of necessity. Size is a kind of weak glue, made from the clippings of parchment, glove-leather, fish-skin, and similar substances, by boiling them down in water. When cold it resembles jelly. It is sold by all oil and colour men, at 1½d. per pound, or 2s. the firkin of 28lbs., and is prepared for use by melting it in an earthen saucepan by the side of a slow fire. About half a pint of water may be put in the bottom of the pipkin in which the size is to be melted, if only a small quantity is made, or water may be added to the size in order to weaken it, in the proportion of from ¼ to ½ pint to each pound of size. The size should be applied warm, and with a large brush, which should be passed once or twice over the wall or canvas. Care must be taken not to work the brush up and down too quickly or with too great pressure, as this has the effect of making the size lather, as it has been said in section 1616.

Size, how to prepare it.

1653. The wall being sized it is necessary to determine what tools are absolutely necessary for the paper-hanger's work. These may be summed up as a pair of boards connected by hinges, or, if preferred, simply grooved and tongued together, or even joined by dowels or pins. These boards, when opened out to their full width on hinges, or when joined together by the other modes stated, form, when supported on trestles, a suitable table on which the strips to be pasted may be laid face downwards one above another. The amateur need not provide himself with a pair of boards and trestles merely for the sake of papering a single room; a kitchen table, if long enough, or even a dining-table suitably protected, will answer every purpose. The boards are portable, and therefore useful to the regular paper-hanger, who may not find any suitable table at the house to which he is going. They are also of greater length than most tables, which is obviously an advantage. Whether the amateur is provided with boards or not, he must of necessity have a pair of good-sized scissors ; a pail to hold his paste, whether of wood or iron it matters not, so long as it is clean ; and a paste brush, something similar to that used for white-washing, but smaller.

Tools required in paper-hanging.

Boards and trestles.

1654. Good paste for paper-hanging is made of old flour, mixed to a milk-like consistency with water. When put in the saucepan to boil, a little size or glue may be added, which will increase its

tenacity. A little alum may also be added to paste, in order to cause it to spread more freely; this ingredient has the property of keeping paste sweet and wholesome, and it is generally used in the thicker kinds of paste, such as shoemakers' paste, partly for this purpose. The paste when boiled should be of the thickness of ordinary gruel, and must be laid on the paper smoothly and equally with backward and forward strokes of the brush. Care should be taken not to load the brush with too much paste at one time, lest the paper should be rendered too damp. It will sometimes happen that through an over-abundance of paste a little is pressed out at the edges when the cloth is used to dab the paper against the wall. Any paste that makes its appearance should be removed by means of a sponge dipped in clean water, but the amateur must do his best to avoid smearing the colours of the paper. The colours will often be started in a slight degree by the influence of the damp paste, and if the surface be smeared the only thing that can be done is to paste a piece of fresh paper over the smear, which, if left as it is, will prove a continual eyesore.

Good paste for paper-hanging.

1655. We must now go on to the method of hanging the paper, but even here a few more remarks with regard to the preparation of the walls may be of advantage, especially as this materially affects the appearance of the walls when finished, according as it has been well done or ill done.

Method of hanging paper.

1656. If the surface of the wall is clean, smooth, and level, all that need be done is to coat the plaster or canvas with thin or weak size. This is done because paper will stick better to a sized surface than to unsized plaster or canvas. If the wall has been whitewashed or coloured, the coating that it has thus received should be wetted with a brush dipped in clean water, and scraped with a piece of iron, such as a plane-iron, having a sharp smooth edge without notches. After scraping, the wall may be swept down with a stiff broom. If it so happen that there are any loose bits of plastering, such as may have been produced by driving nails into the wall, they must be removed altogether, and the depressions made good with plaster of Paris; or they may be well sized and pieces of thin but strong paper pasted over them. All cracks or holes should be filled with plaster of Paris, or have strips of paper pasted over them. After this the room may be sized for papering. In all cases when a room is to be re-papered it is recommended to damp the old paper and remove it entirely, and

Why a wall should be sized.

Preparation of whitewashed wall.

Loose bits of plastering.

Cracks to be filled up.

when there has been sickness in the room this is imperative, as it has been said.

1657. If, however, it be determined not to remove all the old paper, all loose pieces in the corners and elsewhere should be torn away, and the parts of the wall thus laid bare should be sized. In some cases, when it is desired to hang the paper with more than ordinary care, the walls, after being sized, are covered with lining paper. Of course, damp spots must be treated with naphtha and shell-lac, or covered with pitch paper, a black paper. The ordinary wall-paper may be hung on this as soon as it is up. It will take a little longer to dry in these spots, because the spot, in the first place, is damp, and secondly, a double quantity of paste has been put on below the two coats of paper.

Papering over old paper.

Treatment of damp spots.

1658. Where to make a commencement in hanging a room with paper will be a bit of a puzzle to the amateur paper-hanger. "The rule is," says Spon in his "Workshop Receipts," "that the edges of the paper when hung shall be towards the window;" that is to say, that if there be a window in the room the paper must be hung from either side of the window round the room, the junction being finally effected in some corner of the room or some recess, where the mismatching of the pattern would not be so apparent.

Where to begin to hang paper.

1659. There is another way, which perhaps is preferable, and that is shown in fig. 741. Suppose that this figure represents the elevation

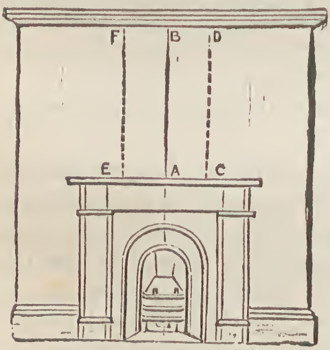

Fig. 741. Paper-hanging: where to begin it.

of a chimney-breast, that is to say, the projection between two recesses, one on either side, and in which are the fire-grate and the passage upwards for the escape of the smoke. It generally happens that of all parts of the room the chimney is the chief point of vision or object of view, if we may call it so. The chief ornaments in the room are there, and in nine cases out of ten, unless the space be occupied by a pier-glass, the best picture in the room is hung there. When this is the case it is manifestly desirable that the pattern on both sides of the chief central object should be similar. To effect this, find A, the centre of the mantel-shelf, and from A, by the aid of a plumb-line or plumb-level, erect the

Another method.

perpendicular, A B. Having cut a length of paper sufficient for the purpose, *divide it in the centre of the pattern*, either by a fold over, which will come out when damped, or a pencil line down the back, and having pasted it fix it to the wall so that the crease or pencil mark comes directly over the perpendicular A B. Half of the piece will then be to the right of A B, and half to the left, as shown by the dotted lines C D, E F. Of course the edges of this piece of paper will not have been cut away, but the edges of succeeding strips must be cut away accordingly, those on the side C D being cut on the left side, and those on the side E F cut on the *right* side. That no mistake may be made in this respect it must be remembered that the outside end of the roll of wall-paper always shows the part that should go uppermost. It is as well to mention this, although in the majority of papers the appearance of the pattern itself will be sufficient to indicate it.

Finding the perpendicular.

1660. The part at which the commencement is to be made having been settled to the satisfaction of the paper-hanger, the next step is to prepare the paper for hanging. To this end it will be as well to settle where the finish is to be made, that is to say, in what out-of-the-way corner the expanse of paper advancing from both sides is to meet and join ; and to prevent waste it will be necessary to take the measuring-rod and ascertain how much of the paper must be cut on one edge, and how much from the other : in either case, whether the commencement be made on both sides of the window, or with a central slip over the fireplace, the mode of procedure must be the same, and the only rule that it is necessary to remember is, that—

Procedure after determining commencement.

Preparation of the paper.

The edge which is cut away for one side must not be cut away for the other.

1661. When it has been ascertained by actual measurement how much paper is required for hanging on each side of the commencement, wherever it may be, whether on each side of the window or over the mantel-shelf, proceed to cut the paper. The usual way is to unroll the paper for a yard or two, cut the edge on one side, roll up the paper just cut, lightly and loosely, and continue unrolling, cutting and rolling up by a yard or two at a time till the other end of the roll is reached. Some will then cut the other edge, proceeding in the same way until the paper is rolled as it was before the cutting commenced, having the topmost piece at the outer end. It is important to remember that whichever side is cut close to the pattern, the opposite side must not be cut closer than

Cutting edges of paper.

from ¼ in. to ½ in. of the pattern. The edge that is not cut close need not, in point of fact, be cut at all; the chief object in cutting it is to leave as small an extent of overlapping as possible where the strips are joined together.

1662. When the edges are cut the next step is to cut the paper into lengths suitable to the height of the room, and this, whether the overplus at top and bottom be much or little, must be done in such a manner that when the second strip is pasted up by the side of the first the pattern will join neatly and exactly, leaving as few traces as possible, if it leave any, of the line of junction. The "match" is shown by certain marks on the edge of the paper, and if it be found that a considerable length of paper be left either at top or bottom, or at both, it will be better and more convenient for the amateur in carrying out the operation of hanging each slip to cut off the surplus paper, leaving no more than an inch or two at top and bottom beyond the length between skirting and cornice. Cut the paper straight across, which can be easily done by aid of the pattern, and cut as many lengths as will suffice for one or two sides of the room to begin with. Lay the lengths thus cut face downwards on the pasting-board, letting the edge of each strip as it is laid down project a little beyond the edge of that which is immediately below it, as in fig. 742, in which the uppermost strip is the last strip laid down. This prevents the paste from getting under the edges of the piece below when the piece above is being pasted.

Cutting paper into lengths.

Matching the paper.

How to dispose paper for pasting.

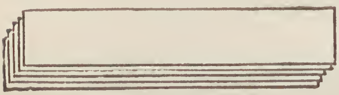

FIG. 742. DISPOSITION OF STRIPS OF PAPER FOR PASTING.

1663. As many strips as may be required having been laid one on top of another on the board, the first strip may be pasted, but a little judgment must be used as to the time that may be allowed to elapse before the paper is attached to the wall. If the paper be cheap, and therefore thin and unsubstantial, it must be hung up as quickly as possible after the paste is put on; but if it be a stout, good paper, some two or three minutes may elapse between pasting and hanging; and a thick paper, especially glazed and flock papers, may be left even twice as long, to allow the damp to penetrate the paper and render it more easy of manipulation and less liable to be crushed or broken. For easier manipulation it is better to loop up the lower end of the paper as shown in fig. 743, the paste causing the paper to adhere slightly where one part comes in contact with another, as

Pasting and hanging paper.

at A. Then fold back the top as at B, and putting the hands, which should be perfectly clean and free from paste, under this fold, attach the paper to the wall at C, bringing the top upwards with the hands to meet the cornice. Care should be taken beforehand to make a guide line on the wall, or to see that the wood-work round the window is perfectly upright, and this will assist the amateur in fixing the first strip truly perpendicular. After attaching it lightly to the wall the plumb-line may be applied to see that all is true and vertical, and if all is right release the fold at A, and after letting the paper hang straight down lift it away from the wall, except for about 6in. or 8in. below the cornice, and then let the strip go, when it will gently float down into its place.

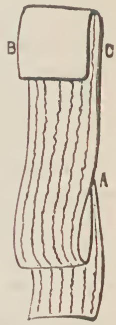

FIG. 743. LOOPING UP PAPER FOR HANGING.

Letting paper fall into place.

1664. The next step is to press the paper against the surface of the wall in every part, and for this purpose the amateur must be provided with some clean soft cloths. First of all, the paper must be pressed down the middle from top to bottom with firm but gentle pressure, avoiding all rubbing, which may have the effect of starting the colour and smearing and spoiling the paper. Then press from the centre outwards on both sides in a downward direction. The paper in some cases will lay smooth and flat against the wall, but if the paper be cheap and thin there will in all probability be many wrinkles all over the surface. Do not attempt to press these flat. The paper has stretched under the influence of the moisture of the paste, and as it dries it will contract again and lay as flat as possible all over the wall to which it is attached. Lastly, draw the scissors over the paper just below the cornice and just above the skirting-board, making a crease. Then pull the paper gently from the wall as far as may be necessary, cut off the edges along the mark or crease made by the scissors, and restore the ends to their places, dabbing them lightly as before with the cloth, which should be so doubled up as to form a large, loose pad. The second strip may now be put up in the same way. Here, however, the chief anxiety will be to match the pattern neatly, for if the first strip be put up perpendicularly the other strips will be perpendicular as a matter of course. Nevertheless it will be as well for the amateur to test his work occasionally by the plumb-line, to make sure that it is not getting out of the perpendicular.

Pressing paper against wall.

Trimming edges above and below.

Manipulation of second strip.

1665. *It may be that the amateur will not be successful in his first effort, and then all that can be done is to sacrifice the strip of paper,*

pull it down, and try again. As in everything else, practice is necessary to enable a man to do this kind of work well and quickly. It will be advisable, then, for any beginner to try his 'prentice hand in an attic or some small room of no great consequence, in order to give him some idea of the way in which paper must be handled and attached to the wall. He will soon gain confidence in himself, and find no great difficulty in papering other rooms where it will be absolutely necessary that the work be neatly and accurately done.

How to rectify mistakes.

1666. Unless the cornice be coloured in parts, having the principal tints in the paper repeated in it, the line of junction between the paper and the cornice above and the skirting-board below seems hard and abrupt; and if this be the case when a cornice intervenes between paper and ceiling, it is still more so when there is no cornice, and the vertical planes of the walls abruptly meet the horizontal plane of the ceiling. It was a feeling of this kind that led in the first place to the addition of borders to paper-hangings, which has the effect of diminishing, if not of entirely removing, this abruptness.

Why borders came into use.

1667. If borders are used they should be neat in design, and match the paper in this respect and in colour, or if the colours do not harmonize they should be in agreeable contrast. A cable pattern generally looks well, or the Grecian rectangular pattern, known as the Greek key pattern. The representation of a simple moulding is often very effective, and when the paper is plain in character and geometrical in pattern a floral border is admissible. It must be remembered, however, that a border, however good it may be, tends to detract from the apparent height of the room, and therefore is not so well calculated for a low room as for a high room, to which the horizontal lines of the border impart an appearance of breadth and space. Borders are expensive in comparison with wall-papers, a very ordinary narrow border costing 1d. per yard.

Patterns of borders.

1668. There is no finish equal to that of a small and simple gilt moulding, which may be carried round the room above the skirting-board and under the cornice, or at the junction between the walls and ceiling where there is no cornice. The gilt moulding does not separate a coloured cornice from the paper in the same conspicuous manner as a border, and it shows up the paper in much the same manner as a gilt frame shows up an oil painting.

Gilt moulding as finish.

1669. Gilt moulding suitable for the purpose can be purchased at most paper-hangers and picture-frame makers at prices from 8s. 6d. per

length of 100 feet, ½ inch wide and upwards, according to the width of the moulding. They may also be purchased of Mr. George Rees, 41, 42, *and* 43, *Russell Street*, *Covent Garden*, *W.C.*, whose stock is large and varied. When any decoration of this kind is used it should be small and simple for a small room, increasing slightly in width for rooms of larger size. In all cases care must be taken not to over-do this kind of ornamentation. The slips can be attached to the walls by small French nails, if they are not already furnished with means of attachment of this kind inserted before the moulding is gilt, so as to prevent disfigurement by the heads of the nails. Still, even in this case, a little of Judson's gold paint, prepared by Daniel Judson and Co. (*Manufacturers of Judson's Dyes*), *Ludgate Hill*, *London*, *E.C.*, will be effectual in hiding the heads of the nails.

Where to buy gilt moulding.

1670. Some years ago there was a style of paper-hanging much in vogue, consisting of dividing the walls of the rooms into large panels. This has been in a great measure superseded by the imitation chair-rail and dado, the pattern above the rail being altogether different to that which forms the dado. The amateur is advised not to adopt either style, for unless the rooms be large and lofty neither will be found satisfactory.

Panel papering.

1671. In the imitation dado style, the dado and the paper covering the upper part of the room are put on first, and the chair-rail or broad line of demarcation between the two last of all, care being taken to indicate its position by marks carefully adjusted by means of level and straight-edge, so that it may be truly horizontal when pasted up in its place. When a room is to be panelled, the surface of the walls must be duly marked out so as to show the position and size of the panels, and the width of the styles and rails of the framing, before an atom of paper is put in its place. All this is a mere question of accuracy in drawing the horizontal and vertical lines marking out the respective parts; and it is obvious that unless this be well and truly done, and the lines carefully followed when drawn, the work will be thrown away, as nothing is more offensive to the eye than anything out of the straight, whether vertical or horizontal. When the walls have been fairly marked out, the paper that composes the panelling may be pasted up, and that which forms the styles and rails of the framing, taking care always that the corners of the styles and rails where they meet are properly mitred, unless corner-pieces specially made for the purpose are used. This done, the mouldings that cover and hide the junction of the other pieces of paper are put on, care being taken as before

Imitation of dado, etc.

Panelling, etc., must be marked accurately.

that they are accurately upright or level, and that the corners are properly mitred.

1672. Of course there are various styles of panelling in paper for rooms, but that which has been described will afford the key to the method of putting up all. An effective decoration in this style for a large room is formed by panels of pale green or rose-coloured paper covered with a diaper pattern in a darker or lighter tint, and edged by a gilt moulding, the styles and rails of the framing being formed of wreaths or lines of red and white roses on a pale, warm grey or cream-coloured ground, the latter being preferable. This style of decoration, however, is not well suited for the display of more than a few pictures—one, two, or three, as the case may be—within a panel, but their position is always governed and regulated by the panels. The pictures, in fact, spoil the effect of the panels, and the panelling carries away the eye from the pictures; therefore, if the amateur love pictures—and they will give more genuine pleasure to the beholder than all the best paper-hangings in the world could do—let him be content to have his walls simply coloured and stencilled, so as to afford an appropriate back-ground to his pictures, whether they be paintings or engravings, and eschew paper-hangings altogether.

Effective decoration for large room.

Effect of pictures in panels.

1673. Dust will cling to any surface, and to paper-hangings as readily, if not more so, than any other. The best method of cleaning paper is to sweep down the surface with a soft white cloth tied over the hairs of an ordinary sweeping-broom, and then to rub it lightly all over with stale bread, using for this purpose a loaf cut in four pieces. The principle involved is precisely the same as that by which black-lead, and soils from similar substances, are removed from white paper, by rubbing it with bread or india-rubber. The dust has an affinity for the cleansing substances, and sticks to, and is carried away by, them, until the surface is so thoroughly impregnated with dirt that paper is soiled rather than cleaned by contact with them.

How to clean wall-paper.

1674. Papers that are varnished do not catch and hold the dust so much as those that are not, owing to the smooth gloss that the varnish imparts to the paper. The wall-paper should first be sized with two coats of good, clean parchment size, after which it may be varnished with any kind of varnish that is used for paper, and it should receive two, if not three, coats of the varnish. Varnished paper is especially suitable for halls, passages, etc., as the varnish renders it extremely durable, and gives a surface that may be

Varnishing paper.

washed with a little lukewarm water and a little soap, used sparingly and with caution, or with weak tea-water, made by filling the teapot with water and letting it stand after it has done its morning or evening duty in the parlour and kitchen. This will be found to be an excellent solution for cleaning all *varnished* work, whether it be wood, paper, or picture that is so protected.

How to clean varnished work.

1675. From paper-hanging we pass, by an easy and not altogether unnatural transition, to *glazing*, the last branch of household building art on which we shall have any occasion to treat here. The amateur's work in glazing will be chiefly confined to mending a broken window in house, greenhouse, or frame-light. He will seldom do any glazing on a large scale, unless it be necessary to re-glaze a frame-light, for cucumber-frame or any cold pit or place protected by glass, or to glaze the roof, sides, etc., of a small greenhouse.

Glazing.

The glazing that amateur will do.

1676. The subjects to which we are chiefly bound to give attention in considering glazing are, first of all, glass—its qualities, sizes, and prices, and the forms most convenient for the amateur; secondly, the tools that are used in cutting glass and in glazing; thirdly, how to repair a broken pane of glass, with hints on the measurement of spaces to be filled with glass; fourthly, how to glaze a new frame-light entirely; and, lastly, how glass may be cleaned, or darkened by artificial means so as to prevent the entrance of the full light of the sun, without using either blind or sun-shade of any kind.

Subjects requiring attention.

1677. Firstly, then, with regard to glass, the kinds that are chiefly used in glazing, that is to say of English-made glass, are crown and sheet glass: these sorts are most in request for window-sashes and glazing generally; but for shop-windows and for the better kinds of houses plate-glass is much used.

Kinds of glass used in glazing.

1678. Crown glass is circular in form, with a thick lump called a bull's-eye in the centre. Before it is sent out it is cut into two pieces of semi-circular shape, one of which is, of course, larger than the other, because the line of division must run on either one side or the other of the bull's-eye. Crown glass is not much used now, but formerly it was in great request, the thickened lump in the centre being cut out and preserved for use in cucumber frames, the windows of small cottages, etc. It is brought into the circular form by whirling round a piece of molten glass that has been taken from the furnace and begun to cool. Centrifugal force soon compels it to assume the form of a large flat, thin disc. Sheet glass

Crown glass.

is cast, as its name implies, and so also is plate glass. The thinnest crown glass that is made is $\frac{1}{16}$in. thick, but the better qualities are thicker. Sheet glass is reckoned according to its weight to the foot superficial, 15ozs. and 21ozs. being the qualities most commonly used, although it is made as heavy as 42ozs. to the square foot. The price varies according to size and quality, the qualities being distinguished as best, seconds, thirds, and fourths.

Sheet glass.

1679. The glass that is most commonly kept and sold by oil and colour men and those who cut glass for the trade is Belgian sheet glass, and this the amateur will chiefly use. It is good enough for all ordinary purposes, and cheap enough, being sold in small quantities at the rate of 3d. per foot super. Thus, if a man wants a pane of glass 12in. wide and 18in. long it will clearly cost him 4½d., because a piece of glass of these dimensions contains 1½ft. superficial. The amateur is recommended always to have his glass cut for him instead of attempting to cut it himself, although if he be living in the country, and at some distance perhaps from a town, it will be necessary for him to be able to cut his own glass.

Belgian sheet glass.

1680. Our mention of this material will not be complete without notice of the Patent Rolled Rough Glass, which is particularly useful for the panels of glazed doors and the roofs of greenhouses. It is made in large squares, but will be supplied to sizes as ordered, the most convenient for general use being about 12in. wide by from 36in. to 60in. long. Its thickness varies from ⅛in. to ⅜in. in thickness, and its roughness, although light will pass through, takes away its transparency, and prevents anything on the other side of it from being seen clearly. For roofs of greenhouses which cannot well be protected with blinds it is very useful, because its want of transparency protects plants from scorching under the rays of the summer sun as effectually as any blind, while, when once heated, the house does not quickly cool because the thickness of the glass prevents the escape of the heat within.

Patent rolled rough glass.

Useful for roofs of greenhouses.

1681. Before proceeding any further it may be as well to dwell for a moment on the prices of glass, and say that when the glass is required in a small piece, comparatively speaking, for a window-pane, it is better to go to the oilman, or any glass-cutter to the trade; but if a quantity of glass be wanted for a greenhouse it will be found much cheaper to buy horticultural window-glass, which will be supplied ready cut to certain sizes, or in crates for the amateur to cut up himself. If the glass is cut to a certain gauge, the frames to receive it must be made

Prices of glass.

Glass for horticultural buildings.

to suit it with regard to length, and the width between the sash-bars; but if the glass is to be cut up, the frames may be made to suit the building.

Prices of glass from glass-cutter, etc.

1682. As it has been said, the glass supplied by the oilman and glass-cutter to the trade is 3d. per foot, generally speaking, though a few years ago the writer bought it for 2½d. and even 2d. It is useless to go into the prices of crown, sheet, and plate glass, because they differ so much according to size and quality; it will be sufficient to refer the reader to Laxton's "Builders' Price Book." It may, however, be said that fluted sheet may be obtained at a slight advance on plain sheet, if the amateur wish to use this for the roof of his greenhouse; and that patent rolled rough plate varies from 6d. to 11d. per foot super., in crates for cutting up, according to its thickness. If cut in squares to order it is more expensive.

Prices of glass for horticultural buildings.

1683. Returning to horticultural window-glass, or glass supplied expressly for the purpose of glazing sash-frames, conservatories, greenhouses, etc., this may be obtained of Mr. Alfred Syer, *Glass, Lead, Zinc, Oil, and Colour Merchant*, 8, *Pentonville Road, London, N.*, who sells a large variety of sizes, 15ozs. to the foot super., at 12s. 6d. per 100ft., or at the rate of 1½d. per foot, and 21ozs. at 16s. 6d. per 100ft., or very nearly 2d. per foot. A considerable advantage is therefore derived by the amateur by buying glass for greenhouse work in this way.

Sizes in which glass is supplied.

1684. The sizes in which the glass is supplied may be obtained on application. Further large sheets, in cases for cutting up, may be obtained at the following rates:

THIRDS.	FOURTHS.
15oz.............40s. per 300ft. or at 1⅗d. per ft.	15ozs. ....30s. per 300ft. or at 1⅕d. per ft.
21ozs.............40s. per 200ft. or at 2⅖d. per ft.	21ozs. ....30s. per 200ft. or at 1⅘d. per ft.

Ready-made lights.

1685. In building a greenhouse the amateur may, if he can afford to do so, save himself much labour by constructing his roof of lights procured direct from some horticultural builder, such as Messrs. Boulton and Paul, *Rose Lane Works, Norwich*, who will forward their price list post free to any applicant, and whose goods may be depended on as being of first-rate quality.

Sizes and qualities of ready-made lights.

1686. These lights are made of the best red deal, thoroughly seasoned, and put together by first-class workmen. They are painted with three coats of good oil-colour, glazed with the best 21oz. glass, every pane of which is nailed in and bedded in with putty. When used for frames each light has an iron handle attached to it for pulling it up and pushing it down, and

each has an iron strengthening bar across. The prices of these lights are, if glazed and painted as described, 16s. each; if unglazed and unpainted, 5s. 6d. each. They measure 6ft. 1in. long by 3ft. 10¾in. wide, but lights of any size will be made to order at slightly advanced rates. The lights are sent carriage paid to any railway station in England, and on orders of 40s. and upwards carriage is paid to Dublin, Glasgow, and Edinburgh. If any glass is broken in transit sufficient is sent to replace it, carriage free.

1687. Of course the amateur builder will understand that he must make his building according to the size of the lights; thus, a double series of 6ft. lights, 4ft. in width, will conveniently form a roof for a house about 11ft. in width, and any multiple of 4ft. in length: thus if it be 16ft. long a double row of 4 lights will be wanted: if 20ft. long, 5 lights, and so on. The upper series may be contrived as sashes to slide down over the lower series, and thus be adapted to promote ventilation. Only every other light should be movable, and thus it is desirable to use an odd number of lights; for example, if five lights be used, the first, third, and fifth in the upper row can be fixed, and the second and fourth made to slide up and down. This is not information on glazing, perhaps some readers will say, but, notwithstanding this, it is hoped that it is a hint that will prove useful to many.

Building must be made to size of light.

Some lights must be movable.

1688. Occasion has already been taken to advise the amateur to procure such glass as he may require for glazing already cut, especially if he be about to cover in any considerable space with glass. It requires some little knack and experience to use a glazier's diamond with good effect. Every diamond must be held at a certain angle to cut glass, and as the angle will differ slightly for every diamond, or fragment of a diamond, that is used for this purpose, the inclination to the glass at which the diamond will best do its work must be ascertained by actual use. Thus it is that while one man can cut glass readily with a diamond, another can do little or nothing with it. It is, however, desirable that the amateur should possess the means of cutting glass, as it will often happen that through his want of skill in taking measurements, or through inattention of the glass-cutter to the measurements given to him, the glass will not fit. If it be too small there is nothing to be done but to get a larger piece cut; but if it be too large it can easily be reduced to the size required.

Glazier's diamond: how to use it.

1689. The amateur will not cut pieces of glass of any great size, and therefore a board measuring 3ft. by 2ft., or 2ft 6in. square, or even

2ft. square, will be large enough for a cutting-board. This board should be clamped at the ends, and its surface should be perfectly true and level. It will be of great assistance to him if he carefully graduates this board along two of its adjacent edges, or even if he divides the area into squares, the lines which represent the inches being thicker than those which denote half-inches, quarter-inches, etc. Thus in fig. 744, the lower right-hand corner of such a graduated board is shown, the edges A B, A C being graduated each way from A in inches, half-inches, and quarter-inches. If this be done there is no occasion to have the straight-edge of the T square used as a guide for the diamond graduated, unless it be for the sake of eighths of inches, which could be marked on the cutting-board just as well, though they need only be indicated at the edge. Thus, supposing that two of the adjacent edges of a piece of glass are true, or have been cut true, and it is required to cut a smaller pane 4in. by 3in. from a broken piece, for example, lay the glass on the board so that the true and square edges coincide with A B and A C, and then putting the T square over the glass at 3, run the diamond over the glass and break away the piece thus cut, and next lay the T square on the glass at 4, and with the diamond make another scratch, so as to take off the other piece that is over and above the quantity required. If the board is not graduated, the edges of the blade of the T square must be of necessity divided into inches, etc. The T square itself will need no description further than saying that the cross-piece which is brought against the edge of the board should be 1ft. long, and the blade that lies on the glass from 2ft. to 3ft.

Hints and appliances for cutting glass.

The graduated board.

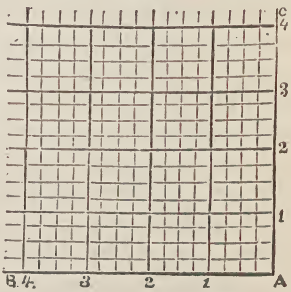

FIG. 744. GRADUATED BOARD FOR GLASS CUTTING.

1690. The best kind of tool for cutting glass is undoubtedly the glazier's diamond, which consists of a handle about 6in. long, flattened on two sides that it may be more easily grasped with the thumb and fingers, and fitted at the lower end into a piece of steel of rectangular shape, and bevelled at the bottom as shown in fig. 745. In using the diamond, which projects from this bevelled end as shown in the illustration, the face of the bevel should be held parallel to the surface of the glass. The cutting edge of the diamond makes a clean, clear cut or scratch from side to side,

The glazier's diamond.

FIG. 745. GLAZIER'S DIAMOND.

and by applying a gentle pressure the parts thus divided will come apart with a slight snap. Glaziers' diamonds when new cost from 15s. to 21s.; but it is possible to purchase them at prices ranging from 5s. to 10s. at unredeemed pledge shops and dealers in second-hand mathematical instruments. Such a man, for example, as Mr. Archbutt, *Mathematical Instrument Maker, Westminster Bridge Road, London, S.E.*, who keeps a first-rate stock of new and second-hand instruments of every description, would not fail to supply any amateur who might send to or visit him with a good second-hand glazier's diamond.

Where to buy it second-hand.

1691. Fortunately, however, for those who could not or would not feel disposed to give even 5s. for a glazier's diamond, a cheap and efficient tool for cutting glass is to be found in the American Glass-cutter, which consists of an iron handle, as shown in fig 746, made like the diamond, so that it may be firmly grasped with the fingers and thumb, and bevelled at the lower end. This end is further cut along its length to receive a small steel wheel of extreme hardness, whose circumference projects for a short distance beyond the surface of the bevel. When this wheel is drawn over a piece of glass, a considerable degree of pressure being applied, the circumference crushes or scratches the glass, and the glass may be broken apart along the scratch thus made. Owing, possibly, to the inability of the amateur to keep the same pressure on the instrument throughout its course along the glass, the scratch made by the wheel of the cutter is not always complete, and the glass will break irregularly.

American glass-cutter.

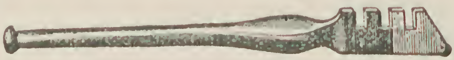

Fig. 746. American Glass-cutter.

How to use it.

1692. On examining the glass-cutter it will be noticed that there are notches of different widths in it. These are to enable the operator to break off any projecting pieces of glass that yet remain beyond the crack. This is easily done, and, in nineteen cases out of twenty, without injuring the piece that is wanted for glazing. Sometimes, however, an accident will happen, and the piece will be broken; and so, although the glass-cutter can be recommended for reducing pieces of glass that have been cut a little too large to the required size, or for cutting a pane at odd times to repair breakages, it is for this very reason and to avoid waste that the amateur is advised when he has a heavy job of glazing in hand to get his glass cut for him, or to buy it ready for use from some wholesale dealer in glass for horticultural and other purposes. The American Glass-cutters are sold for 1s.

Notches in glass-cutter.

each. Excellent ones may be procured of MESSRS. CHURCHILL AND Co., *American Merchants*, 28, *Wilson Street*, *Finsbury Square*, *E.C.*

1693. Lastly, the amateur will require a putty-knife, without which it is impossible to finish the puttying by which a pane of glass is secured in its place, and bring the putty to an accurate and even bevel, slanting in every direction from the surface of the glass to the outer surface of the frame, so as to throw off the water that falls on the glass. A good putty-knife may be bought at from 9d. to 1s. For removal of the remains of a broken pane and the putty by which it is held, and which has grown extremely hard by age and exposure, a knife, technically called a hacking-knife, must be used. It has received this name because the removal of old glass and putty from a sash-frame is termed "hacking out" in the trade. The knife itself is a stiff, wedge-shaped blade, broad at the back and bevelled away to a point at the top, inserted between two pieces of stiff leather which serve as a handle, and which prevent the blows given to the knife by the hammer to cut out the broken glass and hard putty from jarring the hand. Most amateurs who try this kind of work, most likely because they know nothing about the hacking-knife, use their putty-knife or a chisel, much to the detriment of either. A hacking-knife costs from 6d. to 9d., and the amateur who does his own glazing will find that money laid out in the purchase of one will be well spent.

The putty-knife.

Knife for hacking out.

1694. Let us now look at the *modus operandi* to be followed in repairing a broken pane of glass. In the first place, the broken glass and putty must be removed with the hacking-knife, leaving the rebate into which the glass has to be fitted as clear as it is possible to make it. If the injury done to the glass be but small, an effort should be made to preserve the largest fragment intact by cutting round it with a diamond and glass-cutter and pushing it out, holding a lump of putty against it that it may not fall to the ground and be broken. Sometimes it may be taken out whole without cutting round it, but cases in which this is done are very rare.

Repairing broken pane of glass.

Clearing the rebate.

1695. The rebate having been cleared, the next thing to be done is to measure the length and breadth of the opening *inside* the rebate—that is to say, along the dotted lines shown in fig. 747 from the heavy lines which show the full extent of the opening. The lighter lines within show that part of the rebate against which the glass lies or is bedded, and which is at right angles to the other surface. The measurement is always best

Measuring size of glass required.

taken in the middle of the opening, across it in both directions as

FIG. 747. MEASUREMENT OF PANE IN SASH-FRAME.

shown by the dotted lines. It will be as well to say that the proportions of the sash-frame shown in fig. 747 are exaggerated for the sake of showing the rebate and the mode of measurement more clearly. Supposing, for example, that the exact measurement of the opening to be glazed is 18in. by 12in., the glass should be cut ⅛in. less each way, that is to say, 17⅞in. by 11⅞in. This causes the glass to be $\frac{1}{16}$in. less every way than the opening that is to receive it, and insures its fitting in easily. The best mode of measurement is to mark the length and breadth of the opening accurately on a lath, and tell the glass-cutter that this is the exact size of the space to be filled; he will then take care to cut the glass a trifle less in length and breadth that it may slip easily into its place. If the amateur trust to measurement by feet and inches, so accurate a fit may not be obtained as that which is insured by measuring in the manner just described.

Where measurement should be taken.

Allowance in measurement.

Best mode of measuring.

1696. The glass having been procured ready cut for use, or cut by the amateur if he possesses the appliances for doing the work, a bedding of putty must be carefully laid round that part of the rebate against which the glass is to be placed, and the pane pressed in firmly against it, the necessary pressure being given by rubbing the thumbs along the edge of the glass. The bedding to receive the glass should be put all round the rebate, and the putty should not be spared, for if there be not sufficient there is a chance that the pane of glass may be cracked. When firmly fixed in its place putty must be applied all round the edge of the pane and shaped to a bevel by the aid of the putty-knife; the surplus putty that has been forced out on the inside of the pane by the pressure used in putting the glass in its place must also be removed.

Bedding of putty for glass.

Puttying in glass and finishing.

1697. Putty may be bought of the oil and colour man at 1½d. or 2d. per lb. It is made of whiting mixed with as much raw linseed oil as is necessary to form it into a stiff paste. When putty has been allowed to get hard it may be restored to its former condition by heating it and working it up again while hot. This is the reason why a piece of hardened putty grows plastic when held and worked up with the hand. The amateur is advised to buy his putty ready made, and not to attempt to make it for himself. For

Putty: its cost.

iron frames, or in any position where the rebate is of small size and but little putty can be used to fix in the glass, some white lead may be mixed with the putty, or putty may be made of white lead and litharge specially for the purpose. To avoid the disfigurement arising from the juxtaposition of white putty with putty that has been painted, when mending a broken window for example, some colouring matter may be worked up with the putty to assimilate its colour as closely as possible to the colour of the painted part. Soft and new putty should always be used for bedding glass, because it is yielding and plastic, and will give way to the pressure brought to bear on the glass to bring it into its place.

Putty should be bought ready made.

Coloured putty.

1698. The following recipes for making soft putty and for softening hard putty are taken from Spon's "Workshop Recipes," a very useful book, for which a place should be found on the shelves of all amateur artisans.

How to make putty.

Recipe.—*Soft Putty.* "Mix 10lbs. of whiting and 1lb. of white lead with the necessary quantity of boiled linseed oil, adding to it half a gill of the best salad oil. The salad oil prevents the white lead from hardening, and preserves the putty in a state sufficiently soft to adhere at all times, not suffering the wet to enter by getting hard and cracking off, as is often the case with ordinary hard putty."

Soft putty.

1699. The best way to preserve ordinary putty from cracking is to paint it as soon after it is put on as possible; and when putty has dried and cracked to such an extent that it allows the wet to enter, it is best to remove it and substitute fresh putty, or to run a brush charged with priming over the putty, working the bristles well into the cracks, and then to rub soft putty into the cracks to fill them up, after which the work should receive at least two coats of paint.

To keep putty from cracking.

1700. The following is an excellent way to soften putty:—"Take 1lb. of American pearlash and 3lbs. of quick-stone lime, slake the lime in water, then add the pearlash and make the whole about the consistence of paint. Apply it to both sides of the glass, and let it remain for twelve hours, when the putty will be so softened that the glass may be taken out of the frame with the greatest facility."

To soften putty.

1701. Hard putty may also be softened prior to removal by drawing a red-hot iron along it, and this mode of taking glass and putty out of old frames and garden-lights will be found useful when it is necessary

to proceed to re-glazing. Care, however, must be taken when using the red-hot iron not to injure the wood-work. A frilling-iron used by laundresses will be found to be just the thing for this purpose.

Softening putty by heat.

1702. Before glazing a new frame or any new wood-work, the frame or sash, or whatever it may be, must first be primed or painted with the first coat of paint. Putty has an affinity for glass and paint, and will adhere readily to either and harden ; but for wood in its natural state, or for stone, putty has but very little, if any, affinity, and for this reason it is necessary to paint wood-work before any glazing is done.

Treatment of wood-work before glazing.

1703. In glazing a new sash-frame the work is merely the operation of glazing a single opening multiplied by the number of openings formed by the frame and transverse sash-bars ; and if the amateur knows how to glaze a single opening properly, he may undertake any amount of work of this kind. All that he has to remember is that, after the manner adopted in roofing with slates or tiles, the first pane of glass is inserted between the sash-bars at the bottom, and means must be taken to give the first pane that is put in a suitable inclination, so that the overlapping part of every pane rests flatly on that of the pane immediately below it. When one pane does not fit accurately on another at the overlapping, water will make its way between the pieces of glass, and in extremely cold weather this water will freeze, often breaking the glass. Dust is also apt to enter and lodge in the overlap, and as time wears on the accumulation gives a dirty appearance to the glass, which can only be got rid of by taking out the glass, washing it, and re-glazing.

Proper inclination to glass.

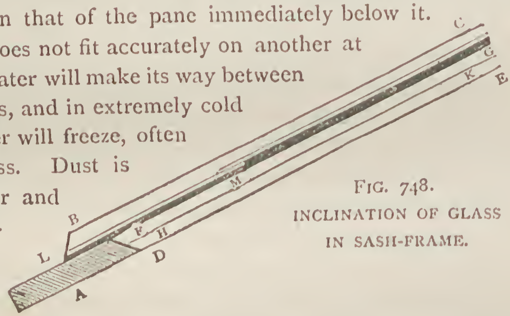

FIG. 748.
INCLINATION OF GLASS IN SASH-FRAME.

1704. The means to be adopted to procure a proper inclination for the panes will be better understood from fig. 748, in which the section of the lower part of a garden light is shown just where the sash-bar is let into the lower rail. In this, B C indicates the top of the sash-bar, D E the bottom, and F G the line of the rabbet in which the glass is laid, the line H K being a line at which the sash-bar is bevelled away on either side towards the bottom to give it a lighter appearance. Fig. 749 shows a transverse section of the cross-

How to secure it.

bar, in which the letters indicating the lines in fig. 748 are repeated so that the same points and positions in each figure may be readily identified.

Disposition of putty.

Putty is spread along the bottom rail thickly at L, and carried away to nothing up the rebates on either side of contiguous sash-bars in which the pane rests that is about to be put in. On this the glass is bedded, resting on the wood, or with a very thin layer of putty between the glass and wood, at M. For the reception of the next pane the same process is repeated. At the bottom of the pane, namely at M, sufficient putty is laid in the opposite rebate to allow the under surface of the second pane to lay flat on the upper surface of the first pane, and the putty is carried away up the rebate to nothing at G. By this expedient the overlapping of the glass is rendered as complete and efficient as it can be.

FIG 749. SECTION OF SASH-BAR.

Extent of overlap.

In glazing, no possible benefit can be derived from having a broad overlap. Half an inch is sufficient in every case for overlapping, and in glazing for orchard houses it is thought to be quite enough to bring edge and edge of the glass together. The less the overlap, in reason, the less lodgment is given for dust and dirt, and consequently the less the disfigurement when the accumulated dust and moisture has turned green.

To clean glass.

1705. To clean glass, a little soap and water, lukewarm, may be used, and after the surface of the glass begins to dry it may be polished with a piece of chamois leather. When glass is very foul and dirty, it is useful to dissolve a little stone ammonia in water, and apply the solution thus made to the glass with a piece of rag; the ammonia in the water takes hold of and removes every particle of dirt, leaving the glass, after it has been polished, beautifully clear and translucent.

Darkening glass.

1706. It is sometimes necessary to darken glass, or to produce an imitation frosting on the surface of glass, to render it semi-transparent, or so that while light can pass through it is not possible to see through it. For temporary purposes, a solution of Epsom salts, brushed over the glass, will immediately crystallise, crystals forming all over the surface; but when anything more durable is required, a little white or green oil-paint should be used.

How to imitate frosting.

In this kind of work a painter's brush should be used—one that is tolerably well worn is better—and a little colour being taken up on the ends of the bristles, it should be dabbed all over the inside surface of the glass, in a manner resembling "stippling" in painting in oils, etc. On glass treated in this way a pattern may be traced with the blunt end of a thin

stick, giving the appearance of a clear pattern on ground or frosted glass.

1707. A preparation for painting the insides of greenhouses, etc., has recently come into use, to which the name of "Summer Cloud" has been given, because its effect on everything within the house is exactly like that of a cloud passing over the face of the sun. This is highly recommended, and may be procured of most nurserymen and seedsmen, or of oil and colour men, at a cost not greatly exceeding that of paint.

"Summer cloud."

1708. It now only remains to give a few memoranda with regard to glazing that will be useful to the amateur, which cannot conveniently be classed under any of the sections in which the entire subject has been divided and grouped for greater facility of treatment.

Memoranda on glazing.

1709. First, with regard to the mode adopted for cutting circular panes, an operation which the amateur may never have to put into practice, but which he may as well know how to do. The centre of the circle to be cut having been ascertained by measurement, a flat plate is placed over it, covered with wax or some substance that will cause it to adhere to the glass on the lower surface, and having a hole sunk in the centre in the upper surface. This plate need be no bigger than a penny. An arm, having a pivot to work in the hole sunk in the plate, and graduated in inches and parts of inches, carrying a socket which holds the diamond, and by which the diamond can be removed to any desired distance from the centre, is then placed over the glass, and the pivot is held firmly against the plate with one hand, while the diamond is carried round in a circle with the other hand, cutting the glass as it goes.

Mode of cutting circular panes.

1710. The amateur may have occasion to use glass in the construction of some models, and especially in making electrical machines. Glass, being so very brittle, is exceedingly difficult to be worked with any degree of certainty by any but those who make glass-cutting their trade. When pieces of glass are bought ready cut it will be found that the edge left by the diamond, even when used by a glazier, is rather rough. For window-panes this is of no consequence whatever; but when it is necessary that the edges should be straight and smooth, and the corners taken off, this can be done by rubbing them on a flat piece of stone, with a little sand and water or emery and water. When it is necessary to remove the gloss from one side of a pane or piece of glass—or, in other words, to frost it—this can be done by rubbing the surface required to be

How to make edges of glass straight and smooth.

frosted upon a flat stone with emery and water. When two pieces are wanted their surfaces can be frosted and brought quite true by rubbing them one against another, with emery powder and water between.

1711. For making holes through glass, the following plan succeeds admirably, and has the merit of being very simple, inexpensive, and, with proper care, certain. A common steel drill, of the size of the hole required, should be made as hard as the steel will allow, and ground to a rather sharp point. The drill must be placed on the glass at the spot to be pierced, and caused to revolve at the rate of about 200 per minute. The sheet of glass must be bedded on putty, which greatly contributes to the success of the operation, because, although sufficiently unyielding to keep the glass up to the drill, it has a certain amount of elasticity. A more rigid material will not be found to answer. The drill, whilst at work, should be kept moist and cool with a lubricating composition made of turpentine and camphor. It is easier to drill a small hole in glass than a large one, but with care and proper attention to the bedding, even large ones may be successfully bored.

Drilling holes through glass.

1712. A tubular piece of glass can be cut without much difficulty with a common saw file, if done under water. The water seems to have the effect of stopping the vibration imparted to the glass by the action of the file, because water is of no use unless the tube is submerged; it is not sufficient to merely keep the file moist.

Cutting tubular glass.

1713. Before leaving the subject of glazing, it is desirable to call attention to the Patent Horizontal Sash-Bars, manufactured only by the inventor and patentee, Mr. Thomas A. Bickley, 7, *Thorp Street, Birmingham.* By the aid of these bars, the amateur artisan is enabled to construct a glass roof for a greenhouse, or any other structure, without resorting to the use of putty, and with but very little paint. The ordinary sash-bars are vertical, that is to say, they are placed in a sloping direction from the top to the bottom of the roof; but the sash-bars made by Mr. Bickley are placed in a horizontal position, from side to side of the roof. The principle on which these bars are made is shown in fig. 750, in which C represents a portion of the rafter on which the sash-bar rests, and B the sash-bar itself; G is a strip of lead or metal nailed along the bevel along the uppermost edge of the bar, with copper nails; and it may be said that the bars are all supplied ready for use, with the metal strips nailed to them. Supposing

Bickley's Patent Horizontal Sash-Bars.

Structure and use of bar.

this to represent part of a bar fixed in position, the bottom edges of the upper row of panes of glass rest on the part A of the metal, and are held firmly down in place by the clips E, E, E, which are bent upwards for the purpose, as shown in the diagram. The upper edges of

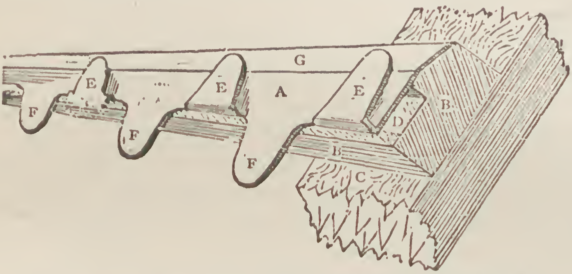

FIG. 750. BICKLEY'S PATENT HORIZONTAL SASH-BAR.

the lower rows of panes are laid along the rabbet D in the sash-bar B, and are held in place by the clips F, F, F, which are pressed down upon them. The clips F, F, F serve also to carry the water from the upper panes far down on to the next row of panes, and the sloping part G also carries all condensed moisture safely away from the inside of the glass on to the next row of panes, thus preventing drip, which exists in the ordinary method of glazing.

1714. In fig. 751 the section of a pit or greenhouse roof is shown, on a scale of 1in. to a foot, which exhibits the simplest mode of covering in a structure of this kind. B is a rafter 3in. deep by 1½in. wide; C, C are patent horizontal sash-bars, let into the rafters by means of notches cut into them ¼in. in depth, and nailed on with wire nails; F, F are sections of panes of glass; H is the eaves-board, with a strip of patent lead J nailed along it to receive and hold down the lower edges of the lowest row of panes; N is the wall-plate; M, a hinged flap-board just under the eaves-board, for ventilation; X is a hinged flap-board or light for top ventilation; W is the wall against which the structure is built, and Y the front wall, or row of lights in front, according as the structure is a greenhouse or a pit. The bars are made in various sizes, from 1in. × 1in. to 1¼in. × 1½in. in size, and are sold per foot run at prices ranging from 3d. to 3¾d. per foot. For small structures, the amateur will find the smallest size sufficiently strong; but for large buildings the larger sizes should be used. The lead plates are made of the weight of 3lbs. to the foot super.; but they may be had of 4lbs. to the foot super. at an extra charge of ¼d.

Construction of glass roof with patent bars.

Sizes and prices of bars.

per foot run of the bars. The illustration is given in two parts, *a, a*, and *a, a* in each portion showing their connection.

Precautions to be taken.

1715. It should be said that though the lead clips should be bent on to the glass when in its place, they should not be pressed down in such a manner as to allow the whole of the lower surface of the clip to lie flatly in contact with the upper surface of the glass, because when in this position the lead sucks the water up. The rafters may be placed from 4ft. to 6ft. apart at the utmost, according to the size of the sash-bars, the smaller bars requiring less width between the rafters; but from 3ft. to 5ft seems to be a safer distance as the maximum, and, at the same time, by no means so close as to cause any diminution of light. In fixing the bars it is a good plan to strain a chalk line *tightly* where one of the bars, the top one preferably, is to be fixed. Having marked all the rafters with this, the other ones may be measured from these marks, allowing about ⅝in. for lap; thus, if the glass be 18in. long, that is to say, from the top of the pane to the bottom, make the marks 17⅜ in. apart. The bars should then be nailed on, placing the *lower edges* precisely to the marks. It is desirable to try a square of glass occasionally as the work proceeds. Wire or French nails should be used for nailing the bars to the rafters, and when nailing them on the amateur should be careful to avoid the rabbet. Where the glass is not cut true it should be lapped, making the laps towards the south or west, or a strip of glass 2in. wide may be laid over the joint. If, however, the glass be cut true, moisture will not enter.

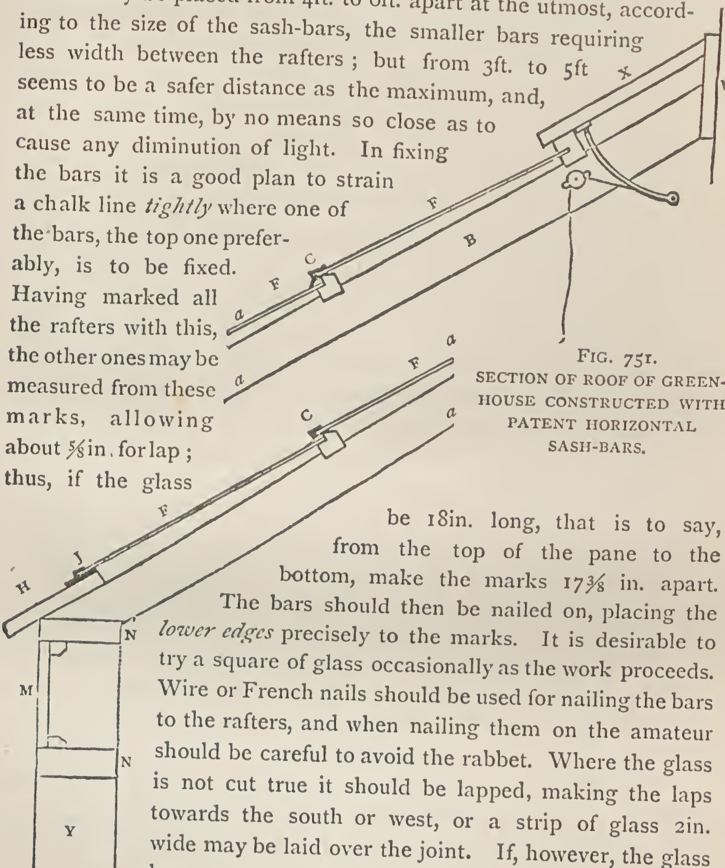

FIG. 751.
SECTION OF ROOF OF GREEN-HOUSE CONSTRUCTED WITH PATENT HORIZONTAL SASH-BARS.

Advantages derived from use of bars.

1716. The great advantages of the mode of glazing introduced by Mr. Bickley are its durability, its cheapness, and the rapidity with which glazing and unglazing, or the insertion of a new pane in place of one that has been broken,

can be performed. It is estimated that a roof made on this principle will last for fifty years, the metal and glass alone being exposed to rain and the action of the weather. The inventor is of opinion that his lead-bars will last a hundred years, and this without the painting and puttying every other year which is necessary to preserve all greenhouses built on the ordinary plan. With regard to the rapidity with which glazing and unglazing can be done, it is estimated that the former may be carried out at the rate of 200ft. super. per hour, and the latter at the rate of 800ft. super. per hour. Mr. Bickley says, with regard to cheapness: My plan costs but little more to commence with, and considerably less when repairs are considered. I give an approximate estimate of the two plans, leaving out wall-plates, frame-work, glass, etc., which are much the same on either side, with the exception of top ventilation, which is simpler and cheaper on my plan; 18in. glass is supposed to be used in either plan and not included.

ONE HUNDRED FEET WITH PUTTY.

	£	s.	d.
80ft. rafter sash-bars, at 1½d.	0	10	0
Mortising and fixing do.	0	3	0
Glazing, putty, and outside painting, 4 coats, per foot, 1½d.	0	12	6
	1	5	6
After repairs, outside painting, etc., per annum 2s. 6d., representing interest at 5 per cent. ...	2	10	0
	£3	15	6

ONE HUNDRED FEET ON MY PLAN.

	£	s.	d.
30ft. rafters..................................	0	4	6
80ft. patent bars at 3d.	1	0	0
Fixing and glazing	0	2	0
	£1	6	6

The balance according to the above statement is largely in favour of Mr. Bickley's plan. Whichever plan is adopted, the first cost of construction is much the same, but in years to come a great saving is effected in fresh painting and puttying.

1717. And here it is necessary to bring to a close the series of instructions in Carpentry and Joinery, and the various branches of the building trade, by which it is sought to help to make

Every man his own Mechanic;

and it is earnestly hoped that the information that it has been attempted to impart may prove as useful to each reader when put in practice as the knowledge of it has been to the writer during the last twenty-six years of his life, in which he has managed to pick it up bit by bit, and use it to his advantage, thereby helping himself to acquire many things that he must otherwise have gone without and done without, for lack of

A few words on what has been written.

means to purchase them, or have them done by others. Although much has been described that the amateur will not do, nothing has been brought under his notice that he cannot do, if his will is good to set about the work and carry it to its finish. Much, too, has been left unsaid that might have been said ; but as a quart measure will hold no more than a quart, so no more information can be given in a certain number of pages than they will fairly contain. It can be urged, however, on the opposite side of the question, that if much has been omitted which might have been introduced, nothing that has been given could well have been left out, and that everything that has been described by words and represented by figures and diagrams will be found to possess a practical value for the practical amateur.

THE END.

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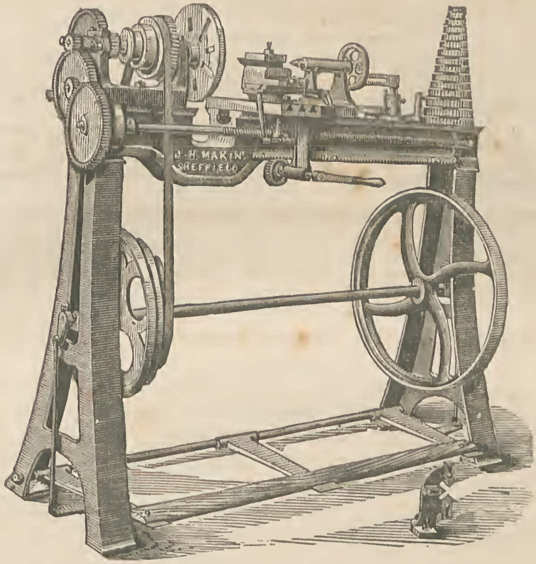

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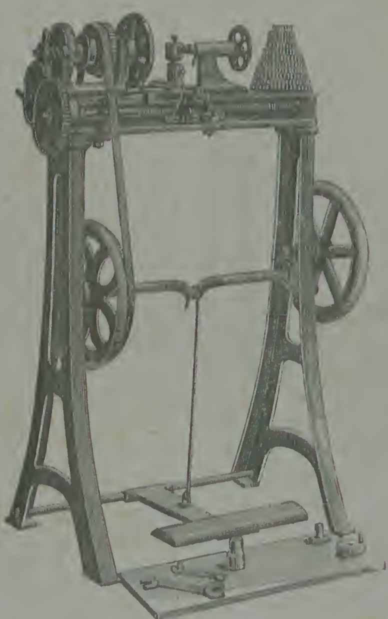

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